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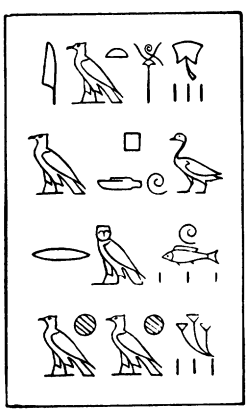
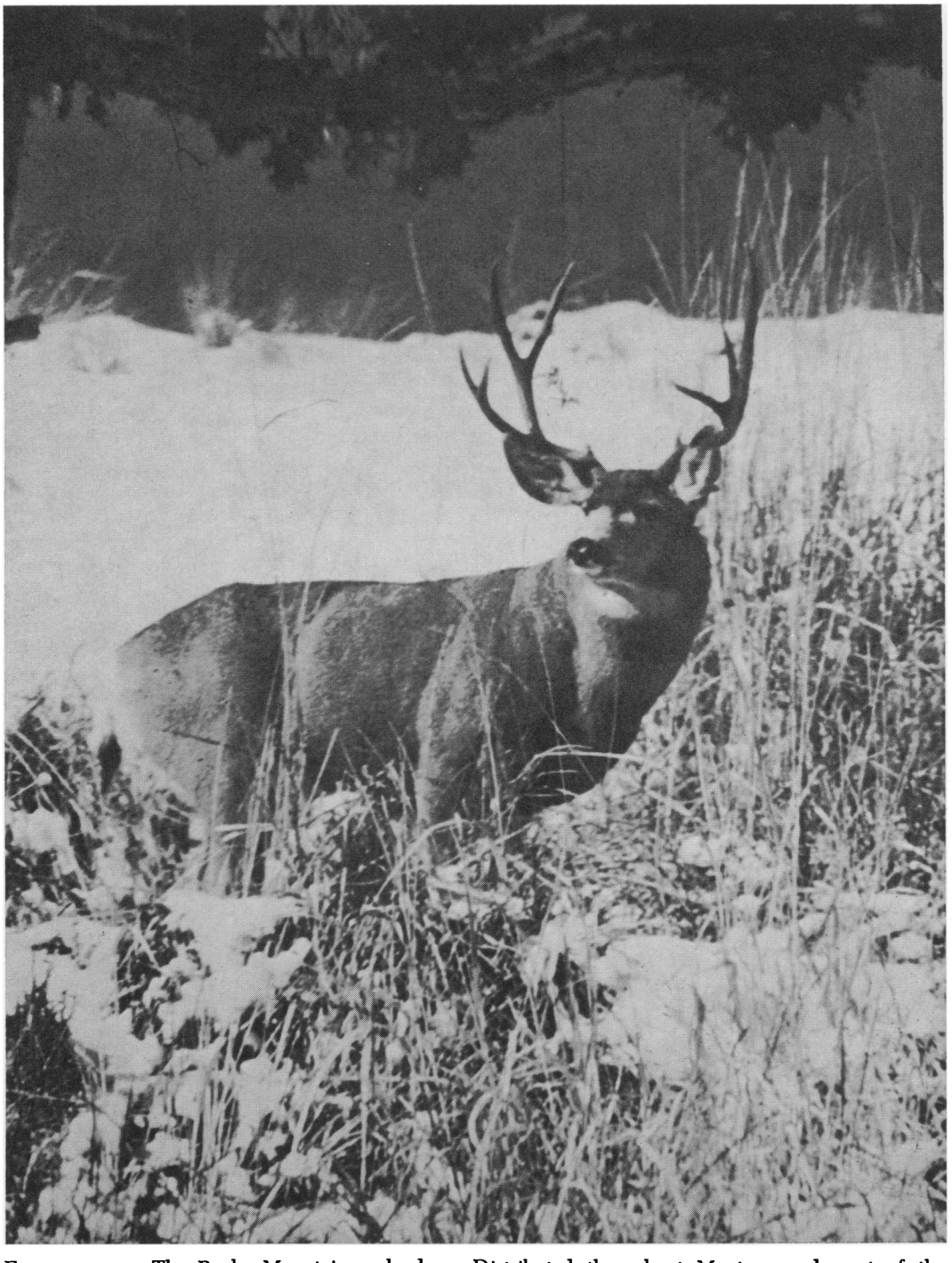


RANGE ECOLOGY AND RELATIONS OF MULE DEER, ELK, AND CATTLE IN THE MISSOURI RIVER BREAKS, MONTANA

by

RICHARD J. MACKIE

MARCH 1970 NO. 20



FRONTISPIECE. The Rocky Mountain mule deer. Distributed throughout Montana and most of the western United States, this species has a history of controversy in relation to domestic livestock and other big game animals which also use these rangelands. Photograph by Eldon H. Smith, courtesy of the Montana Fish and Game Department.

RANGE ECOLOGY AND RELATIONS OF MULE DEER, ELK, AND CATTLE IN THE MISSOURI RIVER BREAKS, MONTANA[1]

Richard J. Mackie[2]

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INTRODUCTION

Vegetation characterized by ponderosa pine, *Pinus ponderosa* Laws, and Rocky Mountain juniper, *Juniperus scopulorum* Sarg., occurs extensively on rough uplands along the Missouri and Yellowstone river drainages and throughout central and eastern Montana. It represents the most important habitat type of mule deer, *Odocoileus hemionus hemionus* Rafinesque, is locally a superior habitat of elk, *Cervus canadensis nelsoni* Bailey, and is heavily utilized in grazing by livestock. Much of this important game habitat is publicly owned, mostly by the Federal Government, and is administered by the U.S. Department of Interior, Bureau of Land Management.

Paucity of quantitative data on big game and livestock range and food habits has hindered the establishment of effective management programs. Clarification of relationships is essential for development of cooperative multiple-use management programs. To aid in the formation of these, an extensive investigation was conducted on a representative 75,000-acre area in the Missouri River Breaks approximately 25 miles northeast of Roy, Montana. Full-time field work was conducted from June 1960 through September 1963. Additional data were obtained during several 1-day to 2-week periods from October 1963 to June 1964. The primary objectives were to obtain quantitative data on range use and food habits of mule deer, elk, and cattle on the ponderosa pine–juniper and associated vegetational types and to develop methods and criteria for management. Habitat and population studies were conducted concomitantly to evaluate the effects of range condition, intraspecific and interspecific conflicts, and current game management practices on mule deer and elk populations. These data also aided in interpretation of relationships between food and range use.

Seasonal and yearlong food and range use habits of mule deer and elk have been studied intensively on many parts of their ranges. Available data on range use and food habits of cattle on western rangelands appear largely observational or derived from studies on forage utilization. Some quantitative, seasonal, and yearlong data for cattle are available for a few areas where big game–livestock relations have been studied.

Few detailed studies of mule deer–cattle, elk–cattle, or mule deer–elk relationships have been made. Julander (1955) possibly presented the most comprehensive data on mule deer–cattle relationships in his report on the Oak Creek Unit of Fishlake National Forest, Utah. Other reports on mule deer–cattle forage relations have been published by Julander (1937) and Kimball and Watkins (1951) for the Kaibab deer range, Arizona, and Dasmann (1949) for the interstate deer winter range, California. Elk–mule deer relationships have been considered previously in comparative winter food habit studies in northern Idaho and Montana (DeNio 1938), the Blue Mountains of Oregon (Cliff 1939), and Jasper Park, Alberta (Cowan 1947). Morris and Schwartz (1957) made a yearlong study on food habits of these two species on the National Bison Range, Montana. Elk–cattle relationships have been studied by Stevens (1966) in the Elkhorn Mountains, Montana, and by Blood (1966) in Riding Mountain National Park, Manitoba. The only study of mule deer, elk, and cattle relationships known to the writer was that of Julander and Jeffery (1964) on summer range relations in Utah.

ACKNOWLEDGMENTS

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Among the many individuals who contributed to the study, I especially wish to extend my sincere appreciation to the following: former Montana Fish and Game Department Game Research Supervisors

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Many members and former members of the Montana Fish and Game Department, especially Reuel G. Janson, Merle Rognrud, Richard R. Knight, Arnold Foss, Kenneth R. Greer, Robert Varner, and the late Thomas H. Leik, participated in various phases of the project. Without their support and assistance, the investigations doubtless would have been much less successful.

Thanks are also due my wife, Barbara, for her patience, encouragement, and assistance in preparing the manuscript; the many ranchers who gave access to their lands, supplied information or assistance, and extended to me their warm hospitality; and the many personnel of the Bureau of Land Management and Bureau of Sport Fisheries and Wildlife who generously cooperated throughout the study.

METHODS

Vegetational Analyses

Reconnaissance permitted tentative classification of vegetation or habitat "types." Beginning during the winter of 1961–1962, records were made of the presence and abundance of plant taxa at sites used for feeding by mule deer, elk, and cattle. Examination of 287 sites on eight primary habitat types during all seasons of 1962 and 1963 aided in determining phenologies of the various taxa, recognition of unions, and further delineation of communities. Statistical studies were conducted during July 1963 when taxa which characterized communities throughout most of the year had attained maximal development, and those of spring aspect had completed their annual cycles. For each of 12 specific rangeland communities, three representative stands, one each in the eastern, central, and western portions of the study area, were subjectively selected for analysis. The degree and direction of slope, soil type and condition, and the hoofed mammals using each stand were recorded. Sites which appeared to have been grazed recently were avoided.

The primary method of analysis followed Daubenmire (1959). Forty 2×5-dm plots were systematically placed within a $20 \times$ 50-ft sample unit in a relatively homogeneous and undisturbed portion of each vegetational stand. The percentage canopy cover of each taxon and percentages of bare ground and rock were estimated by class for each plot as follows: Class 1 = 0–5%; Class 2 = 5–25%; Class 3 = 25–50%; Class 4 = 50–75%; Class 5 = 75–95%; and Class 6 = 95–100%. The midpoint of each class was the value used in tabulations. Taxa occurring within each stand but not in any of the plots were recorded also. Ground cover was further evaluated by recording whether each of the four, sharply pointed legs of the plot frame contacted bare ground, rock, litter, or living plant material.

Tree and taller shrub composition as well as canopy coverage were studied in the four timbered communities by superimposing four (two in *Pseudotsuga–Juniperus*) line transects at 50-ft intervals across the established sample unit. The 100-ft tape was suspended approximately 30 inches above the ground between two steel stakes. Crown cover of each taxon was measured by using the densiometer (Lemon 1956) in a method described by Dealy (1960). While straddling the line, points of intercept were located with the densiometer. A plumb line attached to the densiometer fell against the tape at the point of recorded measurement.

Scientific and common plant names are from Booth (1950) and Booth and Wright (1962).

Population and Range Use Analyses

Characteristics of mule deer, elk, and cattle populations and use of Missouri

River Breaks rangelands were determined primarily by observations during 521 morning and evening periods along 11 vehicle routes which encompassed all portions of the study area (Fig. 1). Mule deer and elk were recorded during all periods. Cattle were recorded at weekly intervals after August 1960, except during December–March when observations were recorded whenever cattle were encountered on upland winter pastures. Usually, all portions of the study area were visited at intervals of 1 month or less from June 1960 through September 1963, from November 1963 through January 1964, and during March 1964. Environmental conditions (temperature, precipitation, wind velocity and direction, cloud cover, and ground conditions), times of sunrise or sunset, and the duration and distance of travel were recorded for each observational period.

Observations were recorded with respect to time, activity (whether feeding, bedding or loafing, standing alert, or traveling), occurrence on the various habitat types, slopes, and exposures, distances from water, and locations when first seen. Mule deer and elk were classified with respect to sex, age, young per female, and specific behavior whenever possible. Animals were recorded collectively when observed within about 100 yards of each other or when their behavior was indicative of a "group" relationship. The time of day was recorded to the nearest quarter-hour, then converted to the nearest hour relative to sunrise or sunset to provide bases for comparisons of data within and between time periods. Steepness of the slope on which each deer, elk, or cattle occurred was estimated and recorded by class as follows: Class 1 = 0–10°; Class 2 = 10–25°; Class 3 = 25–35°; and Class 4 = 35°+. The direction of exposure was recorded according to compass direction of slope, if any. Distance to the nearest known water source was determined from gridded aerial photographs and recorded by quartermile distance classes. Temporary water, including snow, was not considered quantitatively. When all reservoirs held water, most parts of the study area were within about a mile of a water source. The extent of areas farther from water increased through the summer as less "permanent" reservoirs dried. The location of each observation was recorded approximately to the nearest 0.05 mile from gridded aerial photographs and subsequently grouped into 1.5-mile-square "blocks" to facilitate analyses.

Supplementary range use as well as data on mule deer and elk populations were obtained through aerial (helicopter and fixed-wing aircraft) surveys during May–June, September–October, and December of most years. Additional data on mule deer populations and estimates of hunter harvest were obtained by operating checking stations on main access roads during the first two or three weekends of hunting seasons, field checks of hunters and hunting camps, and posting hunter self-check boxes on all access roads and trails.

Data on movements and home ranges of elk and mule deer were provided by relocations of individually recognizable animals. Some were marked as fawns or calves.

Analyses of Food Habits

Food habits were determined primarily by recording frequencies of plant use by taxon at feeding sites as described by Cole (1956: 16) and others. Use of a rooted stem for grass and grass-like plants, an individual leaf or twig for trees and shrubs, and individual leaves or stems for forbs each constituted one instance of use. The requisite minima during my study for recording data were 50 instances of recent plant use on one habitat type by one of the animals studied. Data usually were obtained for each of the three animal species on major habitat types at intervals of 1 month or less and on other types as opportunity afforded. Use of a taxon was computed as a percentage of the total instances of use on each site. Percentages for various sites were aggregated and averaged within habitat types and time periods (Martin et al. 1946:9).

To aid in interpreting data and establish-

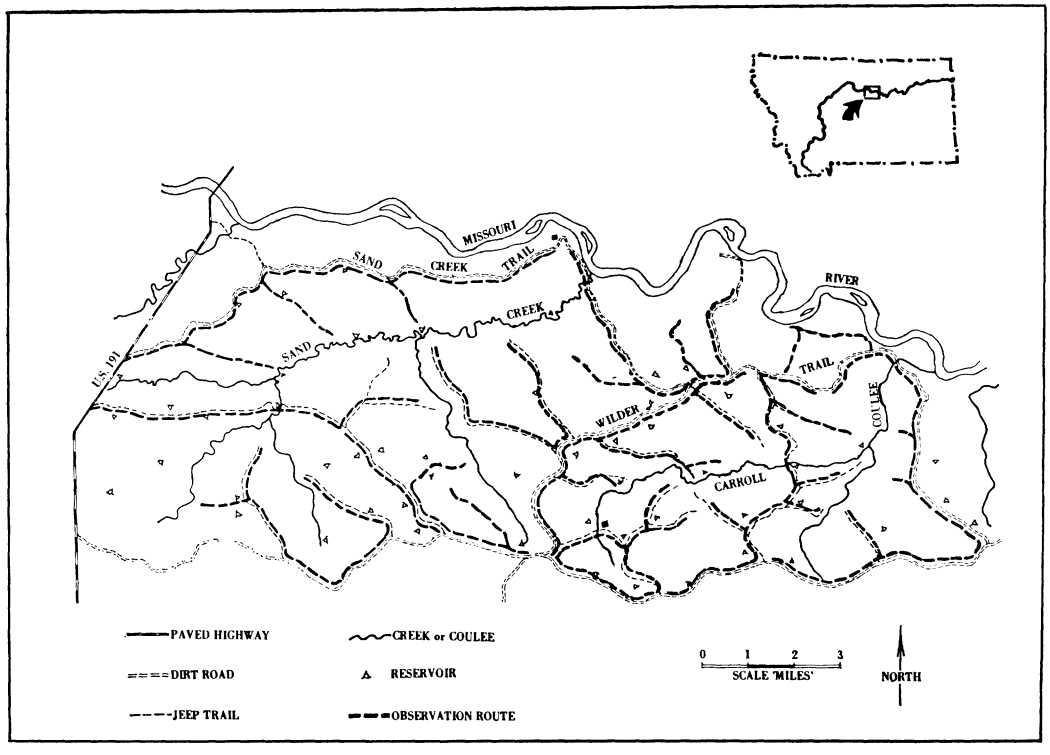

FIG. 1. The Missouri River Breaks Study Area.

ing forage preferences, the abundance of all plant taxa observed on feeding sites was subjectively estimated and recorded by class as follows: Class 1 = rare, usually only a single plant; Class 2 = uncommon, considerable movement and preference associated with substantial animal use; Class 3 = common, some movement and preference associated with substantial use; and Class 4 = abundant, little or no movement necessary for use.

Data from examinations of feeding sites were supplemented by analyses of 1-quart samples of contents of the rumen from each of 37 mule deer, 12 elk, and 18 cattle. Samples for mule deer were from animals killed by hunters or collected specifically for this study. All cattle samples were from animals found dead. The deaths of most of those from which ruminal samples were collected during spring and early summer of 1963 were attributed to sweetclover bloat. Comparable samples from elk were represented by animals found dead as well as intentionally collected. Sorting and measurement of items in the ruminal samples were performed by personnel of the Montana Fish and Game Department Wildlife Laboratory using procedures described by Cole (1956: 20) and others. I assisted in identification of plant materials.

Utilization and condition of important mule deer browse species were evaluated using the key browse survey method of Cole (1958b). Various attempts were made to ascertain elk and/or cattle utilization of important forage grasses using the method described by Cole (1958b:15–17) and by clipping and weighing (see Smith et al. 1963:95). Neither method provided consistent or usable results because of the mobility of elk and/or year-to-year changes in seasonal use of local areas by both elk and cattle.

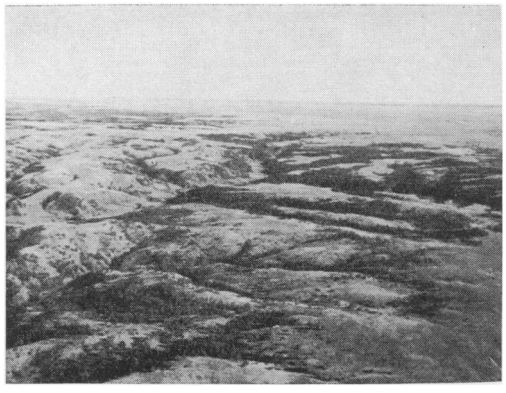

FIG. 2. Typical breaks of uplands adjacent to the Missouri River in north-central Montana. Plains extend southward in the background.

THE STUDY AREA

Physiography

The study area (Fig. 1) extended approximately 20 miles as a 4- to 7-mile-wide belt adjacent to the Missouri River in northeastern Fergus County, Montana. This area is part of a broad dissected plateau which slopes gently to the north and east. The terrain is characterized by "breaks" (Fig. 2). Ridges, sharply cut coulees, and creek bottoms resulting from erosion of the plateau are closely interspersed. Elevations range from about 3,100 ft along the southern boundary to approximately 2,250 ft along the Missouri River. Rolling plains extend, with slightly increasing elevation, to the south and southwest.

The soils, derived from the underlying Bearpaw Formation which consists largely of clay shale containing moderate amounts of alkali and other salts, are predominantly heavy clay loams of the Lismas and Pierre series (Gieseker 1938). Shallow layers of glacial lag may occur on higher level ridgetops. Shale outcrops are common. Alluvial soils of the Havre silt loam and Lohmiller clay loam series are predominant on Missouri River bottomlands (E. K. Hogan, pers. comm., 25 June 1964). Several other soil types occur locally on uplands, terraces, footslopes, fans, and bottomlands. As a group, these "gumbo" soils are relatively impermeable to water, and runoff is high, especially from eroded and sparsely vegetated upland sites. They are considered too shallow, too heavy and plastic, and generally too steep for cultivation (Gieseker et al. 1953:82).

In addition to intermittent streams of the Sand Creek Coulee and Carroll Coulee drainages which flow only during spring runoff or heavy rains, there are several natural springs or seeps and one well on the area. About 30 of the 55 stockwater reservoirs developed by stockmen and the Bureau of Land Management hold water throughout the summer. These are widely distributed except on the extreme southeastern portion where there are no permanent stockwater sources. Most upland water sources were dry by midsummer during 1960 and, especially, 1961.

Access is provided by three graded dirt roads leading from US Highway 191 which forms the western boundary, and by numerous jeep or truck trails in all parts of the area (Fig. 1). As a rule, these roads and trails are impassable when wet.

Climate

The semiarid climate is characterized by moderately low rainfall, comparatively low relative humidity, great extremes in summer and winter temperatures, and many sunny days. Records for the U.S. Department of Commerce weather station at Roy 8 NE, approximately 15 miles southwest of the center of the area, show a 21-year annual mean temperature of 44 F (U.S. Weather Bureau 1943–1964). January, with an average temperature of 16 F, is the coldest month, and July, with an average temperature of 71 F, is the warmest. Monthly and annual precipitation data for the January 1959–May 1964 period and 25-year (1939–1963) means are shown in Table 1. Annual rainfall fluctuates widely between the extremes of 7.03 inches recorded for 1952 and 23.14 during 1962; 11 inches or less total precipitation was recorded for 7 of the 25 years.

Total snowfall amounts to about 25 inches

TABLE 1.—PRECIPITATION IN INCHES ON MISSOURI RIVER BREAKS STUDY AREA, 1959–1964, TOGETHER WITH THE 25-YEAR MEAN. U.S. DEPARTMENT OF COMMERCE, WEATHER STATION, ROY 8 NE, MONTANA

Month	25-Year Mean	1959	1960	1961	1962	1963	1964
January	0.39	0.52	0.87	0.26	0.47	0.85	0.23
February	0.40	0.72	0.43	0.20	0.48	0.92	0.08
March	0.54	0.26	0.28	0.16	0.33	T	1.00
April	0.88	1.01	1.78	0.15	0.30	1.18	1.53
May	2.26	2.84	1.54	1.25	7.58	2.65	—
June	3.42	2.94	1.58	1.41	5.03	3.10	—
July	1.50	1.21	0.23	2.77	2.08	1.25	—
August	1.29	0.41	1.33	0.21	3.67	1.62	—
September	1.14	2.46	0.34	1.77	0.37	1.41	—
October	0.81	1.66	0.06	0.94	1.89	0.23	—
November	0.47	1.13	0.12	0.38	0.78	0.37	—
December	0.33	0.03	0.33	0.11	0.16	0.71	—
Totals	13.43	15.19	8.89	10.61	23.14	14.29	—
Deviation from mean		+1.70	−4.60	−2.88	+9.65	+0.80	

annually. Snow cover seldom persists for more than a few days except during the coldest periods. Warm southwesterly "chinook" winds, characteristic of the region, temper the harshness of the winter and prevent accumulation of snow.

Annual precipitation totals for the 4-year study period represented nearly the complete range of "expected" conditions. The year prior to inception of the study, 1959, was quite normal; however, 1960 and 1961 were marked by drought conditions unmatched in the 25-year records. The total precipitation from January 1960 through April 1962 was only 21.08 inches. This included only 8.42 inches during the most severe drought period which prevailed between June 1960 and July 1961. Exceptionally heavy rain fell during the late spring and summer of 1962, and near average amounts of precipitation were recorded for 1963.

Land-Use Characteristics

Widespread grazing began on the study area and vicinity during the early 1880's (Gieseker 1938:20). According to Gieseker, et al. (1953:22), large livestock companies grazed herds on range forage throughout the year until the early 1900's when many of these organizations failed or were dissolved and were succeeded by local stockmen and smaller herds. Much of the area was taken up under the Homestead Acts and settled between 1906 and 1915 when attempts were made to cultivate upland sites. Recurrent drought conditions, especially during 1918–1921 and 1930–1937, and other factors led eventually to abandonment of most of these lands and a gradual depopulation of the area. At present, only three headquarter ranches persist. Formerly cultivated tracts have reverted to grasslands currently utilized for grazing or occasionally cut for hay. Publicly owned lands now comprise 51,210 acres (68.3%) of the total area. Of this, 47,850 acres are owned by the Federal Government, 3,320 acres by the State, and 40 acres by Fergus County. Approximately 44% of the area lies within the Charles M. Russell Wildlife Range established in 1936 and administered by the U.S. Bureau of Sport Fisheries and Wildlife. Most of the area is open range and grazed by domestic livestock, primarily cattle, but a few horses are included. Occasionally, domestic sheep are grazed into the "breaks" on the south-central portion. I reported observations on the distribution and range use of sheep during the period of study elsewhere (Mackie 1966a). Livestock grazing is administered by the Bureau of Land Management and the Indian Buttes State Grazing District. The grazing season extends from 1 April through

30 November. Winter livestock use is restricted largely to Missouri River bottomlands and two privately owned upland pastures. Approximately 1,500 acres (2%) are cultivated. Except for one small dryland grain field on the western edge of the area, these lands are restricted to bottomlands along the Missouri River where alfalfa, *Medicago sativa* L., and a limited amount of barley, *Hordeum* sp., are grown.

In addition to mule deer and elk which range throughout the area, white-tailed deer, *Odocoileus virginianus dacotensis* Goldman and Kellogg, are common on the Missouri River bottomlands. Allen (1968) reported range use by white-tailed deer and their relationships to mule deer, elk, and cattle on bottomlands of the study area. Pronghorn, *Antilocapra americana* Ord, and an occasional bighorn sheep, *Ovis canadensis canadensis* Shaw, also occur, ranging onto the area from adjacent rangelands.

VEGETATION

Ecological studies of rangelands in eastern Montana are few. Wright and Wright (1948) studied grassland communities in southcentral Montana, and Jonas (1964) described plant communities in the Long Pines of southeastern Montana. Neither these, nor studies in adjacent Great Plains of Canada (Coupland 1950, 1961) and western North Dakota (Hanson and Whitman 1938) seem entirely applicable to the vegetation of the study area. Therefore, the present analyses were undertaken to ascertain vegetational characteristics as a basis for determining intrinsic relationships between the animal species and the habitat.

The terms "Union" and "Association" used in describing the vegetation and evaluating taxa and particular assemblages thereof as food and cover for animals are used in the sense of Daubenmire (1952:302). The union represents the smallest structural unit of organization and is comprised of a single species or of several species closely similar in ecology as indicated by similarity of local environmental amplitude and phenology. Association indicates the distinctive combination of unions superimposed on the same area. It is applied only to what are believed to represent "climax" (either climatic, edaphic, or topographic) communities, notwithstanding the fact that past disturbances undoubtedly have affected species composition. "Associes" are developmental equivalents of associations (Weaver and Clements 1938:99). As used herein, the term denotes the unions or distinctive combination of unions which persist on the same area under disclimax conditions clearly resulting from animal activity (including man's) and/or peculiar topoedaphic conditions which appear to be somewhat less than permanent. A "Series" refers to a group of associations characterized by the same taxa; e.g., the *Artemisia tridentata* series includes the *A. tridentata–Agropyron smithii* association and the *A. tridentata–A. smithii* associes. Daubenmire (1952:303) defined a "Habitat Type" as the collective area which one association occupies, or will come to occupy as succession advances. Because of difficulties in distinguishing associations and/or seral communities at a distance during field observations, the term is used categorically here to include an association or a series and all seral stands thereof: e.g., the *Pseudotsuga* habitat type includes stands in which Douglas fir, *Pseudotsuga menziesii* Mirb., is sparse or absent but unions characteristic of the *Pseudotsuga–Juniperus* association are well represented.

Artemisia–Agropyron *Habitat Type*

This type occurs extensively on level to gently rolling ridgetops where it is largely restricted to slopes of less than 15° and clay subsoils more than 15 inches deep over shale. The type occupies approximately 23,000 acres (31%) of the study area. Recognition is afforded by its physiographic location and prominence of the *Artemisia tridentata* union. The type is represented primarily by the *Artemisia* series, three distinct communities, the distribution and organization of which seems related to livestock distribution, intensity of grazing, and edaphic (soil) conditions. Comparative

TABLE 2.—MEAN PERCENTAGE CANOPY COVERAGE (C), PERCENTAGE FREQUENCY OF OCCURRENCE (F), AND DISTRIBUTION BY UNION OF PLANT TAXA WHICH ATTAINED MEAN COVERAGE OF 1% OR MORE IN AT LEAST ONE COMMUNITY, ON 12 RANGELAND PLANT COMMUNITIES (SEE TEXT). TRACE (T) AMOUNTS ARE LESS THAN 1%. A PLUS (+) DENOTES OCCURRENCE IN ONE OR MORE STANDS BUT NOT IN ANY PLOT

Union: Taxa	*Artemisia–Agropyron spicatum* association C/F	*Artemisia–Agropyron smithii* associes C/F	*Artemisia–Agropyron smithii* association C/F	*Agropyron–Poa* associes C/F	*Pinus–Agropyron* association C/F	*Pinus–Juniperus* association C/F	*Pinus–Artemisia* association C/F	*Pseudotsuga–Juniperus* association C/F	*Artemisia longifolia* associes C/F	*Agropyron–Symphoricarpos* association C/F	*Sarcobatus–Agropyron* association C/F	*Xanthium strumarium* association C/F
Agropyron spicatum:												
A. spicatum	43/89	T/T			20/53	15/39	T/T	16/50	2/8			
Artemisia tridentata:												
A. tridentata	15/50	15/52	19/67	T/T	T/T		T/T				19/42	
A. frigida	1/6		1/11	2/21		T/4						
Astragalus bisulcatus			1/4									
Phlox hoodii	T/T	T/5	2/37								T/2	
Agropyron smithii:												
A. cristatum				20/33								
A. smithii	18/56	57/98	30/98	46/82	17/62	5/19	4/29	+	4/26	88/100	42/91	3/15
Bouteloua gracilis	2/10	T/2	10/52		+	T/3						
Bromus japonicus				T/12						T/T	T/2	
Koleria cristata	3/23	6/28	10/75	T/2	3/13	T/8				T/2	2/13	
Stipa comata	2/13		T/3									
Stipa viridula	5/26	5/27	1/5	5/22	12/34	4/11	T/T	T/2	T/T	4/19	5/26	T/3
Carex spp.	4/26	T/4	3/19		9/48	10/40	T/2	2/9				
Poa secunda:												
P. secunda	T/5	15/58	10/67	16/48	T/5	T/2			T/3	T/T	24/66	T/2
Tragopogon dubius:												
Achillia millifolium					2/15	3/25		3/26		T/T	T/2	
Artemisia ludoviciana					T/3	T/5		T/T	T/T	1/9		
Bahia oppositifolia	T/9				1/18	T/2	T/2				T/2	
Chenopodium album					T/2	T/8	T/5	T/2	T/8	T/3	T/2	3/21
Comandra umbellatum	1/20	1/28	T/13		T/8						T/18	
Melilotus officinalis	T/3	2/12	T/T	13/42	T/T	T/4	+	T/3	6/13	5/23	5/23	25/53
Opuntia polycantha	1/10	1/10	1/10	T/3	T/T	T/7	T/T			T/T	1/10	
Selaginella densa		1/5	1/13			T/13		38/60				
Tragopogon dubius	T/3	T/3	T/T	T/T	2/12	T/3	+	T/T	T/2	T/12	T/3	T/T
Vicia americana	T/13	T/3	4/17	T/7	1/20	1/12		T/4		T/3	T/4	T/T
Juniperus scopulorum:												
J. scopulorum					3/4	19/38	2/3	19/38				
Rhus trilobata					2/5	2/10	T/2	1/3				
Rosa arkansana					1/6	T/3	T/6		3/13	2/15		
Symphoricarpos alba					3/22	T/T						+
Solidago missouriensis					T/8	2/17	T/8	1/10	T/4			
Stephanomeria runcincata					T/8	T/3	2/17					
Thermopsis rhombifolia					1/18		T/4		T/3			
Carex geyeri					8/18	T/T		3/25				
Prunus virginiana:												
P. virginiana						1/6		2/5				
Rosa nutkana						2/6		5/35				
Fragaria virginiana								2/14				
Galium aparine						T/5		3/11				
Geum triflorum								2/15				
Smilacina stellata						1/3		+				
Agrostis scabra						19/43		40/77				
Symphoricarpos occidentalis:												
Artemisia cana										3/5		T/3

TABLE 2.—*Continued*

Union: Taxa	*Artemisia–Agropyron spicatum* association C/F	*Artemisia–Agropyron smithii* associes C/F	*Artemisia–Agropyron smithii* association C/F	*Agropyron–Poa* associes C/F	*Pinus–Agropyron* association C/F	*Pinus–Juniperus* association C/F	*Pinus–Artemisia* association C/F	*Pseudotsuga–Juniperus* association C/F	*Artemisia longifolia* associes C/F	*Agropyron–Symphoricarpos* association C/F	*Sarcobatus–Agropyron* association C/F	*Xanthium strumarium* association C/F
Chrysothamnus viscidiflorus										1/5		2/10
Symphoricarpos occidentalis							6/24		10/53	4/22		
Glycyrrhiza lepidota										2/16		2/8
Agropyron trachycaulum							2/9		2/12			T/7
Poa compressa							T/2		T/T	16/58		T/2
Artemisia longifolia:												
A. longifolia					+	+	2/7		8/35			
Calamovilfa longifolia					+		12/29		3/7			
Sarcobatus vermiculatus:												
S. vermiculatus		1/4							4/10		11/31	T/T
Distichlis stricta										4/23	T/T	1/11
Xanthium strumarium:												
Iva axillaris		T/2							T/7			2/11
Xanthium strumarium												5/20
Elymus canadensis												2/7
Hordeum jubatum											T/T	2/8
Spartina pectinata												2/4

statistical data for these communities are presented in Tables 2 and 3.

The *Artemisia* Series

Artemisia tridentata–Agropyron spicatum Association.—This association (Fig. 3) occurs where a "light," 1–3-inch layer of "topsoil" persists and livestock use has been much restricted as a result of inadequate water supplies or physiographic barriers. It attains widest distribution in areas more than a mile from a permanent water source,

TABLE 3.—MEAN COVERAGE (C) OF BARE GROUND AND FREQUENCY OF OCCURRENCE (F) OF BARE GROUND, LITTER, AND PLANT MATERIAL FOR 12 RANGELAND PLANT COMMUNITIES. DATA ARE PERCENTAGES FOR 120 2 × 5-DM PLOTS AND 480 POINTS, RESPECTIVELY, IN EACH COMMUNITY (SEE TEXT)

Community	Bare Ground		Litter	Plant
	C	F	F	F
Artemisia–Agropyron spicatum association	46	45	39	16
Artemisia–Agropyron smithii associes	54	54	35	11
Artemisia–Agropyron smithii association	50	55	28	17
Agropyron–Poa associes	61	58	34	8
Pinus–Agropyron association	20	14	82	4
Pinus–Juniperus association	21	19	72	9
Pinus–Artemisia association	80	77	22	.4
Pseudotsuga–Juniperus association	1	.2	61	38
Artemisia longifolia associes	94	95	3	2
Agropyron–Symphoricarpos association	37	30	58	11
Sarcobatus–Agropyron association	52	48	38	14
Xanthium strumarium association	90	93	6	.6

FIG. 3. *Artemisia–Agropyron* habitat type. Ridgetop occupied by the *Artemisia tridentata–Agropyron spicatum* association.

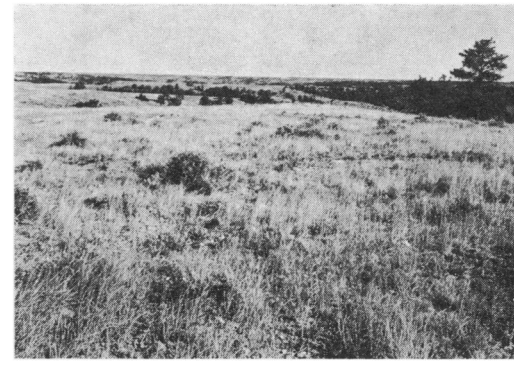

FIG. 4. *Artemisia–Agropyron* habitat type. Ridgetop occupied by the *Artemisia tridentata–Agropyron smithii* associes.

though remnant stands or vestiges may be found at lesser distances. The association is most extensive on the lightly grazed southeastern portion, but isolated stands occur throughout the study area. The presence of "topsoil" seems important. Observations indicate that bluebunch wheatgrass, *Agropyron spicatum* (Pursh) Scribn. & Smith, occasionally occurs in the *Artemisia–Agropyron smithii* associes; but on isolated or marginal areas of both communities, where severe disturbance and subsequent erosion partially or completely removed the topsoil leaving either a shallow, gravelly or claypan soil, the species is either absent or persists only on "pads" (small elevated mounds of soil) around the base of big sagebrush, *Artemisia tridentata* Nutt.

The *Agropyron spicatum* union is dominant (Table 2). Big sagebrush and the *Agropyron smithii* union, comprised of the principal grasses of the mixed prairie (Coupland 1950), are well represented but to a lesser degree than in the other two communities of the *Artemisia* series. The fact that the *A. smithii* union is relatively well developed here may indicate some disturbance in the stands. The *Poa secunda* union, which includes the earliest spring herbs, is scarcely represented; although wild onion, *Allium textile* Nels. & Macbr., and lomatium, *Lomatium foeniculaceum* (Nutt.) C. & R., are common during spring. The *Tragopogon dubius* union, comprised of species of relatively wide ecological amplitude and which attains maximum development in early summer, is best represented by bastard toadflax, *Comandra umbellata* Nutt., plains prickly pear, *Opuntia polycantha* Haw., scarlet globemallow, *Sphaeralcea coccinea* (Pursh) Rhdb., common salsify, *Tragopogon dubius* Scop., and American vetch, *Vicia americana* Muhl.

The association appears to have somewhat greater total ground coverage than any of the other communities which occur on open ridgetops (Table 3). These data support general observations of less runoff during rainstorms and suggest greater soil stability on sites where it occurs.

In view of its distribution on deep, undulating, upland clay loam soils throughout the relatively undisturbed portions of the area, this association may represent the climatic climax type in the central Missouri Breaks.

Artemisia tridentata–Agropyron smithii Associes.—On sites accessible to hoofed mammals throughout the study area where topoedaphic conditions seem similar to those supporting the *Artemisia–Agropyron spicatum* association, bluebunch wheatgrass appears to have been greatly reduced or eliminated and dominance assumed by the *Agropyron smithii* union (Fig. 4). The distribution of this community seems to corre-

FIG. 5. *Artemisia–Agropyron* habitat type. Ridgetop occupied by the *Artemisia tridentata–Agropyron smithii* association.

FIG. 6. *Agropyron–Poa* habitat type. Formerly cultivated ridgetop now occupied by the *Agropyron smithii–Poa secunda* associes.

spond with areas where livestock grazing is periodic, fluctuates as a result of lack of permanent water, or is otherwise restricted by man. Western wheatgrass, *Agropyron smithii* Rydb., is the usual dominant (Table 2); however, either junegrass, *Koleria cristata* (L.) Pers., or green needlegrass, *Stipa viridula* Trin., may dominate local stands. The *Artemisia tridentata* union codominates with little change in importance from the *Artemisia–A. spicatum* association. The *Poa* union is well represented, especially by Sandberg bluegrass, *Poa secunda* Presl., and during the spring, by wild onion, lomatium, nodding microseris, *Microseris nutans* (Geyer) Sch., musineon, *Musineon divaricatum* (Pursh) Raf., and tufted evening primrose, *Oenothera caespitosa* Nutt. The *Tragopogon* union is conspicuous in both the number and abundance of representative species.

The distribution of this community, the paucity of bluebunch wheatgrass, the greatly increased importance of the *Agropyron smithii* union, and the increased representation of forbs all suggest a disclimax condition resulting from disturbance of the *Artemisia–A. spicatum* association.

Artemisia tridentata–Agropyron smithii Association.—This community (Fig. 5) is especially prevalent on the western and central portions and along the southern boundary of the study area. Its distribution seems to correspond with that of shallow, gravelly, or claypan surface soils and generally intensive grazing. Normally, severe spot or sheet erosion is evident in that islands of higher lying soil and vegetation continue to exist. Big sagebrush frequently is elevated on small mounds of soil anchored by litter, little clubmoss, *Selaginella densa* Rydb., and roots of both big sagebrush and herbs which grow through or beneath it. This suggests that degradation of sites normally supporting either of the other two communities has been at least partially responsible for its development. Vegetative cover typically is sparse and depauperate. Much of the total canopy coverage is concentrated on small islands where species and unions are superimposed.

The *Artemisia tridentata* and *Agropyron smithii* unions are dominant (Table 2). Big sagebrush is somewhat more abundant than in either of the previously described communities and its associates are better represented. Rubber rabbitbrush, *Chrysothamnus nauseosus* (Pall.) Britt., and broom snakeweed, *Gutierrezia sarothrae* (Pursh) B. & R., are conspicuous. Western wheatgrass, although less dense than in the *Artemisia–A. smithii* associes, remains dominant; though junegrass and, especially, blue grama, *Bouteloua gracilis* (HBK) Lag., become quite prominent. In contrast to other communities of the *Artemisia* series, green

TABLE 4.—MEAN COVERAGE (C) AND FREQUENCY OF OCCURRENCE (F) OF TREES AND SHRUBS GREATER THAN 12 INCHES TALL ON LINE TRANSECTS IN *PINUS* AND *PSEUDOTSUGA* COMMUNITIES. DATA ARE MEAN PERCENTAGES FOR 12 100-FT LINE-INTERCEPT TRANSECTS (FOUR IN EACH OF THREE STANDS) IN EACH COMMUNITY OF THE *PINUS* TYPE AND 6 100-FT LINE TRANSECTS (TWO IN EACH OF THREE STANDS) ON THE *PSEUDOTSUGA* TYPE. TRACE (T) AMOUNTS ARE LESS THAN 1%

Taxa	*Pinus–Agropyron* C/F	*Pinus–Juniperus* C/F	*Pinus–Artemisia* C/F	*Pseudotsuga–Juniperus* C/F
Pseudotsuga menziesii				56/100
Pinus ponderosa	27/100	14/75	18/73	16/50
Juniperus scopulorum	4/58	53/100	8/88	30/100
Rhus trilobata	T/50	7/88	T/36	T/67
Prunus virginiana		6/50		2/50
Ribes cereum	T/8	T/25		T/17
Artemisia tridentata	T/8	1/50	1/27	
Ribes aureum				T/17
Chrysothamnus nauseosus	T/17			
Artemisia cana			T/9	
Artemisia longifolia			3/73	
Sarcobatus vermiculatus			T/9	
Total Intercept	32	81	31	106

needlegrass is only poorly represented. The *Poa* union is also prominent and on some sites may dominate the community. In local areas, particularly on the western part of the study area, the *Sarcobatus vermiculatus* union frequently is associated with this community.

Observations suggest that this association represents an edaphic climax on sites where it occurs.

Agropyron–Poa *Habitat Type*

This type (Fig. 6) occurs entirely on sites usually characterized by the *Artemisia* series. It is largely restricted to approximately 1,200 acres on ridgetops in the central and southwestern portions of the study area formerly cultivated and/or artificially reseeded with exotic grasses. Differences in time of abandonment or reseeding and past treatment have resulted in diverse vegetational characteristics. The three stands selected for analysis include an area grazed primarily during the winter and infrequently cut for hay, a stand grazed only during the grazing season and occasionally cut for hay, and a recently reseeded stand also grazed during the grazing season. All but the latter are now dominated by native species. Because of the minor extent of the type (1.5% of the area) and some indication that the successional trend on all reseeded areas is toward dominance by the same native grasses, these communities are recognized collectively as the *Agropyron smithii–Poa secunda* associes. The *A. smithii* and *Poa* unions dominate (Table 2). Although the *Artemisia tridentata* union appears to be regenerating slowly, big sagebrush is represented only by scattered young plants and a few depauperate older plants which persist despite occasional cutting, browsing, and trampling. Crested wheatgrass, *Agropyron cristatum* (L.) Beauv., an exotic, joins the *A. smithii* union where seeding has occurred; however, it dominates only the recently reseeded stand. Japanese chess, *Bromus japonicus* Thumb., another exotic, also joins the *A. smithii* union on local areas where disturbance has provided an avenue for invasion. At the time of analysis in late July, characteristic forbs were those of the *Tragopogon* union. During spring, however, the *Poa* union is well represented by wild onion, lomatium, and nodding microseris. The total ground cover provided by this type is somewhat less than that afforded by any community of the *Artemisia* series (Table 3).

FIG. 7. *Pinus–Juniperus* habitat type. Slight south-facing slope occupied by the *Pinus ponderosa–Agropyron spicatum* association.

Pinus–Juniperus *Habitat Type*

This is a major type, covering approximately 45% of the area. It occurs extensively on slight to moderately steep slopes and soils which vary from clay loam less than 15 inches deep over shale to raw shale. It is prevalent on south- or west-facing slopes, but also occurs on northerly or easterly exposure where the degree of slope is slight. The type frequently forms an ecotone between the *Artemisia–Agropyron* and *Pseudotsuga–Juniperus* types.

Stands of pine are seldom dense. A nearly complete overhead canopy may be found in only a few stands on slight, north-facing slopes. Frequently, only scattered pines occur to give a savannah-like appearance, especially on old burns and along the upper limits of the type where it contacts the *Artemisia–Agropyron* type. The characteristically slow growth of ponderosa pine is attested by data obtained by the Bureau of Land Management for a "site" tree in each of 14 pine stands on and adjacent to the study area. These trees, which had a mean approximate age of 83.2 (51 to 141) years, averaged only 32.6 (22 to 46) ft in height and 8.5 (6.4 to 11.4) inches dbh (diameter 4.5 ft above the ground). The mean growth during the last 10 years was 0.29 inch dbh for 36 trees (unpublished data, U. S. Bureau of Land Management, Lewistown, Montana, 1964).

The type usually is represented by one of a series of three more or less distinct communities, the distribution and organization of which appears related to topographic and edaphic factors. Statistical data for the three communities are presented in Tables 2, 3, and 4.

The *Pinus* Series

Pinus ponderosa–Agropyron spicatum Association.—Wherever the *Pinus–Juniperus* type abuts upon ridgetops dominated by *Artemisia–Agropyron* or *Agropyron–Poa*, it characteristically is represented by the *Pinus–Agropyron* association (Fig. 7). At least a shallow layer of clay loam soil seems essential to support the usually well-developed grass understory. Exposed, xeric, upper slopes are also characteristic. On less exposed, more mesic, footslopes and draws, this community is replaced by the *Pinus–Juniperus* association.

Ponderosa pine is dominant and better represented than in either of the other two communities (Table 4). Typical openness of stands is attested by the 27% coverage afforded by pine and the total tree–shrub intercept of only 32%. The principal undergrowth is herbaceous and usually dominated by the *Agropyron spicatum* union. Frequently, however, the *A. smithii* union assumes this position. This may be correlated with the fact that the association characteristically occurs on gentle slopes susceptible to moderate or heavy use by hoofed mammals. The *A. spicatum* union appears less abundant, though plains muhly, *Muhlenbergia cuspidata* (Torr.) Rydb., is somewhat better represented, than in the *Artemisia–Agropyron spicatum* association. The *A. smithii* union appears almost identical in composition and abundance to its occurrence in the latter. Principal forbs are those of the *Tragopogon* union, which differs only in the relative abundance of member species from its occurrence in the *Artemisia–Agropyron* type. The *Poa* union is very poorly represented, although wild onion, yellow bell, *Fritillaria pudica* (Pursh) Spreng., and nodding microseris are com-

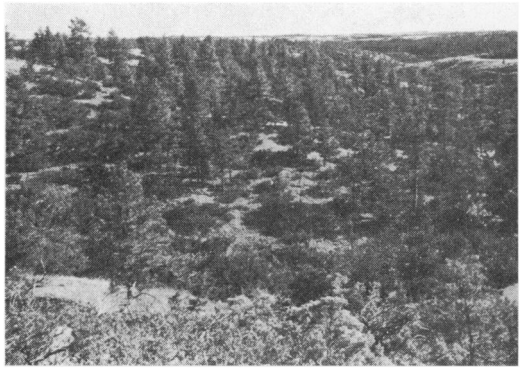

FIG. 8. *Pinus–Juniperus* habitat type. Moderate west-facing slope occupied by the *Pinus ponderosa–Juniperus scopulorum* association.

FIG. 9. *Pinus–Juniperus* habitat type. Steep south-facing shale slope occupied by the *Pinus ponderosa–Artemisia longifolia* association.

mon during April and early May. The shrub layer is comprised mainly of a sparsely represented *Juniperus scopulorum* union in which either Rocky Mountain juniper, skunkbrush sumac, *Rhus trilobata* Nutt., or common snowberry, *Symphoricarpos alba* (L.) Blake, may dominate in local stands. Occasionally, shrubs of the *Artemisia tridentata*, *Prunus virginiana*, *Sarcobatus*, and *Symphoricarpos occidentalis* unions occur as scattered individuals.

Pinus ponderosa–Juniperus scopulorum Association.—On less exposed, more mesic sites along drainageways and south- or west-facing slopes, the *Juniperus* union supplants the *Agropyron* unions in understory dominance (Table 2) and provides this association a distinctive physiognomy characterized by ponderosa pine and dense growths of Rocky Mountain juniper (Fig. 8). Although ponderosa pine usually is prominent, it appears less abundant than in the *Pinus–Agropyron* association (Table 4). This may be due to curtailed reproduction by the shade-intolerant pine under the dense juniper canopy. Common snowberry, which frequently is prominent in open stands of *Pinus–Agropyron*, is suppressed, and the *Prunus* union, comprised of species typical of north-facing slopes, may develop under the shaded mesic conditions. Douglas fir may also occur. The herbaceous layer usually is dominated by bluebunch wheatgrass (Table 2); but on especially protected sites ticklegrass, *Agrostis scabra* Willd., a member of the *Prunus* union, may dominate. The *Agropyron smithii* union is of secondary importance, occurring primarily on alluvium along bottoms of smaller drainageways. The *Symphoricarpos* union usually is associated with the *A. smithii* union on these sites. Forbs are largely those of the *Tragopogon* union with only minor changes in species representation as compared to the *Pinus–Agropyron* association. Distributional limitations suggest that this association represents a topographic climax on sites where it occurs.

Pinus ponderosa–Artemisia longifolia Association.—This association (Fig. 9) is restricted to shale outcroppings on steep slopes where it may represent a topoedaphic climax. These sites usually are unstable, and individual stands characterizing them exhibit considerable variation with local conditions. The community typically is characterized by a very sparse pine overstory, a variable understory usually dominated by the *Artemisia longifolia* union, comprised of species more or less restricted to shale outcrops, and a bare shale soil surface (Tables 2, 3, and 4). The *Juniperus* union is quite prominent and may dominate local stands. Although scarcely represented in the stands analyzed, the *Sarcobatus* union often occurs and occasionally dominates the

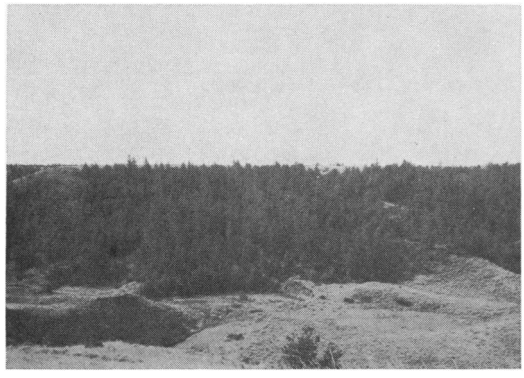

FIG. 10. *Pseudotsuga–Juniperus* habitat type. Steep north-facing slope occupied by the *Pseudotsuga menziesii–Juniperus scopulorum* association.

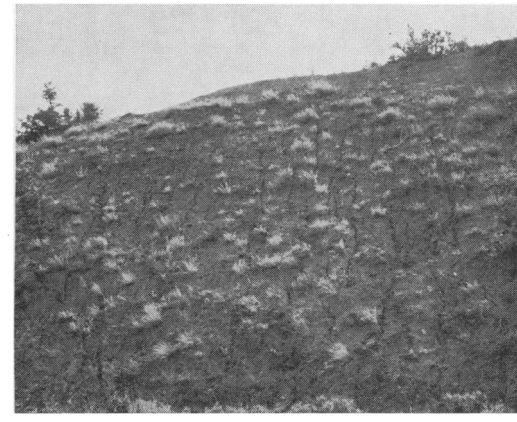

FIG. 11. *Artemisia longifolia* habitat type. Steep, loose shale slope occupied by the *Artemisia longifolia* associes.

shrub layer, especially on steep open slopes in the northern part of the study area. The poorly developed herbaceous layer usually is dominated by sand reedgrass, *Calamovilfa longifolia* (Hook.) Scribn.; however, bluebunch wheatgrass and/or western wheatgrass may dominate on more stable sites. Forbs typically are poorly represented. Lamb's quarter, *Chenopodium album* L., and desert wirelettuce, *Stephanomeria runcincata* Nutt., of the *Tragopogon* union seem most common, but other species of the *Tragopogon*, *Artemisia longifolia*, and *Xanthium* unions may be locally abundant.

Pseudotsuga–Juniperus *Habitat Type*

This type predominates on approximately 10,000 acres (13% of the total) of moderate to steep northerly exposures where cool, mesic conditions prevail (Fig. 10). Occasionally, where well-developed stands of *Pinus–Agropyron* occur on slight north-facing slopes and provide protection, it extends upward onto more level sites. It seems to become slightly more extensive in the Missouri River Breaks west of the study area. To the east, it gradually becomes more restricted. Recognition is afforded by the dominance of Douglas fir or, on seral or burned sites, conspicuous *Prunus* and *Symphoricarpos* unions. Mature and undisturbed sites are characteristically occupied by the *Pseudotsuga menziesii–Juniperus scopulorum* association. Stands of this association usually are characterized by a well-developed tree layer dominated by Douglas fir and dense shrub undergrowth dominated by the *Juniperus* and *Prunus* unions (Tables 2 and 4). Ponderosa pine typically is present but poorly represented in the overstory. Although this species may dominate open, seral, or burned stands, tree reproduction in mature stands, except for open disturbed spots, is limited to Douglas fir. This suggests that pine is seral on these sites, as it is in the *Pseudotsuga menziesii* zone of the northern Rocky Mountains (Daubenmire 1952:310). The *Symphoricarpos* union is best represented by western snowberry, *S. occidentalis* Hook., and slender wheatgrass, *Agropyron trachycaulum* (Link.) Malta., but silver sagebrush, *Artemisia cana* Nutt., and green rabbitbrush, *Chrysothamnus viscidiflorus* (Hook.) Nutt., frequently occur in more open or burned stands. Both chokecherry, *Prunus virginiana* L., and green rabbitbrush are susceptible and sensitive to heavy browsing by mule deer and elk. Dead and depauperate plants attest to greater abundance of these species in former years. The herbaceous layer typically is dominated by ticklegrass and/or bluebunch wheatgrass, the latter being predominant in open, seral, or burned stands. As a group, forbs appear less abundant than on any of

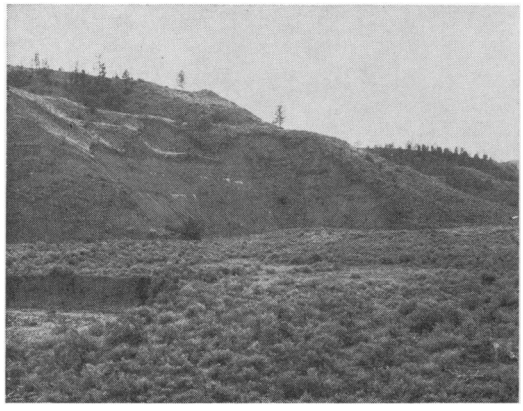

FIG. 12. *Sarcobatus–Agropyron* habitat type. Coulee bottom occupied by the *Sarcobatus vermiculatus–Agropyron smithii* association. The mixed stand shown here is typical except on bottomlands along the Missouri River.

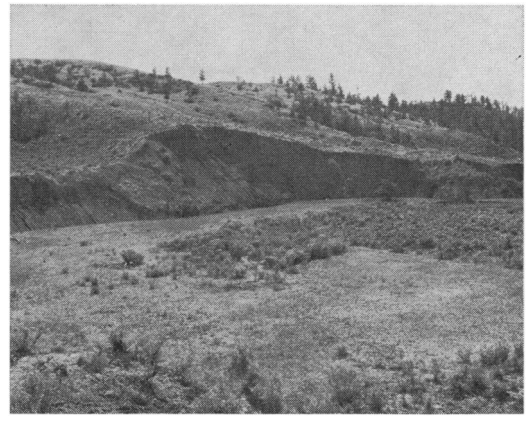

FIG. 13. *Agropyron–Symphoricarpos* habitat type. Coulee bottom meadow occupied by the *Agropyron smithii–Symphoricarpos occidentalis* association.

the other vegetational types; however, little clubmoss often forms extensive mats on the organic matter which tends to accumulate on or near the ground surface, and yarrow, *Achillia millifolium* L., is common. Soil surface cover appears higher than in any of the other rangeland types (Table 3). It appears that this association represents a topographic climax on the sites where it occurs.

Artemisia longifolia *Habitat Type*

This type (Fig. 11) is very limited and occurs only on loose shale of cuts and slopes similar to, but usually steeper than, those occupied by the *Pinus–Artemisia* association. The latter might be expected to supplant the *Artemisia longifolia* associes, which is characteristic, in the absence of disturbance or as more stable conditions develop. This is also suggested by the vegetation of this community (Table 2) which is similar in many respects to the understory in the *Pinus–Artemisia* association. The *Artemisia longifolia* union characteristically dominates the typically sparse vegetative cover (Tables 2 and 3). Longleaf sagebrush, *Artemisia longifolia* Nutt., usually is the most conspicuous shrub, although greasewood, *Sarcobatus vermiculatus* (Hook.), and members of the *Juniperus* union frequently occur. Greasewood is especially prominent and may dominate local stands on south-facing slopes. The depauperate herbaceous layer is comprised largely of grasses and forbs of the *Artemisia longifolia*, *Agropyron smithii*, and *Tragopogon* unions. Occasionally, some members of the *Xanthium* union attain abundance in local stands. Bluebunch wheatgrass may be conspicuous, especially on more stable sites.

Sarcobatus–Agropyron *Habitat Type*

Wherever dispersed clay soils containing considerable amounts of sodium occur, the vegetation characteristically is sparse and dominated by greasewood. Footslopes and low benches along larger coulees and Missouri River bottomlands are the usual sites (Fig. 12); however, the type extends upward along adjacent slopes on clay slides (formed by downslope movement of clay overlying unstable shale). Occasionally it may be found on deep, granular, silty clay soils of higher outwashes or fans and in shallow upland basins. Despite some variation in community organization among the various sites, the usual prevalence of the *Sarcobatus* and *A. smithii* unions seems to justify collective recognition of stands of this relatively minor type (approximately

FIG. 14. *Xanthium strumarium* habitat type. Coulee bottom cut occupied by the *Xanthium strumarium* association.

5% of the area) as the *S. vermiculatus–A. smithii* association (Table 2). Greasewood alone characterizes the shrub layer only on footslopes and benches along the Missouri River, locally along major coulees, and on clay slides. Elsewhere, the *Artemisia tridentata* union codominates in what apparently are mixed stands (Fig. 12). The herbaceous layer typically is sparse, often extremely so; however, where the association occurs in small stands on higher outwashes, it may be well developed. Although the *A. smithii* union characteristically dominates, the *Poa* union is conspicuous and may predominate in local stands. During spring, the latter is well represented by wild onion, lomatium, musineon, spindle plantain, *Plantago spinulosa* Dcne., and fanweed, *Thlaspi arvense* L. Summer forbs typically are of the *Tragopogon* union. Those associated with big sagebrush or the *Xanthium* union are sparse or only locally common.

Agropyron–Symphoricarpos *Habitat Type*

This type (Fig. 13) is minor in extent, occurring only on silty clay soils of flats adjacent to watercourses. Recognition is afforded by a wet meadow aspect dominated by western wheatgrass; however, the *Symphoricarpos* union is sufficiently represented to recognize the community as the *Agropyron smithii–Symphoricarpos occidentalis* association (Table 2). Western snowberry is the most abundant shrub and frequently occurs in dense patches. Silver sagebrush and green rabbitbrush characteristically are present but both are most prominent on better drained, marginal sites. Western wheatgrass is more abundant in this association than any other community, though other members of its union are poorly represented. Canada bluegrass, *Poa compressa* L., and desert saltgrass, *Distichlis stricta* (Torr.) Rydb., typically occur. The latter attains abundance only in lower spots or along the edge of watercourses. Wild licorice, *Glycyrrhiza lepidota* (Nutt.) Pursh, is the most characteristic forb, but members of the *Tragopogon* union usually are common. Wild onion, lomatium, and fanweed are common spring forbs.

Although not analyzed in detail, *Agropyron* meadows on Missouri River bottomlands appeared very similar in organization to this association.

Xanthium strumarium *Habitat Type*

The community (Fig. 14) comprises the vegetation characteristically associated with cuts or beds of intermittent watercourses where the shale, silty clay, or gravelly substrate is typically moist and alkaline. The *Xanthium* union, comprised of species which tolerate or thrive under these conditions, usually dominates the sparse vegetative growth (Tables 2 and 3). Cockleburr, *Xanthium strumarium* L., is the most prominent and widely distributed species. Canada wild rye, *Elymus canadensis* L., prairie cordgrass, *Spartina pectinata* Link., foxtail barley, *Hordeum jubatum* L., and Mexican dock, *Rumex mexicanus* Meisn., are characteristic but usually restricted to marginal silty clay deposits. Where they occur, members of the *Agropyron smithii* and *Symphoricarpos* unions and desert saltgrass are also largely restricted to marginal deposits and clay banks. Yellow sweetclover, *Melilotus officinalis* (L.) Lam., which consistently occurs with the *Xanthium* union on these sites, often attains greater abundance than any

other species but again largely on marginal deposits and clay banks. Where standing water persists for extended periods, spike sedge, *Eleocharis macrostachya* Britt., and/or alkali bulrush, *Scirpus paludosus* S. Nels., may join the association.

Other Plant Communities

Two additional plant communities, characteristic of Missouri River bottomlands, occur on the study area but were not analyzed. These included a *Populus–Symphoricarpos* type, which occurs on approximately 1,000 acres where plains cottonwood, *Populus sargentii* Dode., and western snowberry appear to be typical dominants of the tree and understory layers, respectively; and a *Salix* type, comprising about 500 acres of dense thicket in which sandbar willow, *Salix interior* Rowlee, Bebb willow, *S. bebbiana* Sarg., and Mackenzie willow, *S. mackenziana* (Hook.) Barratt, are common. In addition, approximately 1,400 acres of cultivated bottomland are variously dominated by alfalfa, barley, stubble, or weeds. Allen (1968) has described these bottomland communities in some detail.

POPULATIONS

Mule Deer

Apparently deer were common, if not abundant, in the area at time of settlement. Koch (1941:363) cited journal records of persons wintering on the Missouri River just below the present study area in 1869–1870 who ". . . were able to go out every two or three days, much as we would go to a market, and bring in deer . . ." Information furnished by long-time area residents suggests that numbers of deer declined during the early 1900's to extreme scarcity during the 1920's and early 1930's. A 4-month hunting season with a bag limit of 8 deer established in 1895 was successively reduced to 1 month and 1 male deer with antlers not less than 4 inches long by 1923. From 1921 through 1930, an area encompassing the eastern half of the study area was closed to deer hunting. The entire area was closed during 1931–1932. Although hunting resumed on the study area in 1933, hunting was prohibited within the C. M. Russell Wildlife Range from 1937 through 1947 and again during 1949.

TABLE 5.—ESTIMATED NUMBERS, SEX AND AGE COMPOSITION, AND HARVEST OF MULE DEER ON THE MISSOURI RIVER BREAKS STUDY AREA DURING FALL AND EARLY WINTER 1960–1963

Year	No. Deer/Square Mile		Number Classified	Males per 100 Females	Fawns per 100 Females
	Population	Harvest			
1960	11	3–3.5	668	19.1	86.4
1961	9	3.5–4	430	25.3	39.5
1962	9	2–2.5	190	37.5	54.5
1963	10	1–1.5	362	35.1	84.2

Human depopulation, increasingly effective law enforcement, and predator control together with favorable conditions of the range which developed for deer during the period of scarcity ("storage" of Leopold et al. 1947:173) probably proved conducive to development of the existing population. Increasing numbers of deer were noted during the late 1930's, throughout the 1940's and into the early 1950's. Hollibaugh (1944:5) indicated that the "Breaks" herd was increasing at a tremendous rate under excellent range conditions. Brown (1947:6) estimated the mule deer population as approximately 5 deer per square mile in September 1947. Calculations by Brown and Brown (1950:3) suggested a density of about 7.6 deer per square mile during the winter of 1949–1950. That increases continued until at least 1951 was indicated by calculated post-hunting season populations of 3,330 in 1949, 4,850 in 1950, and 5,230 in 1951 for the Missouri Breaks of Fergus, Petroleum, and Phillips Counties (Johnson 1952:4). No data indicative of sizes or trends of mule deer populations are available for the 1952–1959 period.

Minimal population estimates indicative of trends on the study area during the 1960–1964 period were obtained by plotting numbers of mule deer observed by location on gridded aerial photographs and from aerial surveys during early winter. These data, together with harvest estimates and ob-

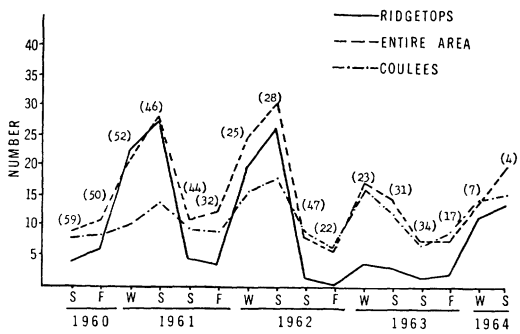

FIG. 15. Mean numbers of mule deer recorded per observation trip on extensive open ridgetop areas, predominantly coulee areas, and the entire Missouri River Breaks study area, 1960–1964. Numbers of observation trips are shown in parentheses.

served late fall–early winter sex and age ratios, are presented in Table 5.

Year-to-year trends indicated decreasing numbers of mule deer from 1960 through 1962 and recovery during 1963 and 1964. The decline in winter populations from 1960 to 1961 appeared to be effected by low production and/or survival of fawns, increased hunter harvest, and probable additional losses related to range conditions. The extremely poor range conditions during 1961 were reflected in a substantially reduced increment for 1962. The effects of improved range conditions after the spring of 1962, reduced numbers of mule deer, and a female segment comprised largely of older animals was manifest during 1963 in a relatively large fawn crop and an increased late summer population. Further increase apparently occurred during 1964 when, with continued good fawn production, the increment resulted in a late summer population approximately equal to that of 1960. Reproductive performance and other phenomena associated with the dynamics of the mule deer population during and following the study period are further discussed in another report (Mackie 1966b).

Numbers of mule deer observed per observational trip (Fig. 15) were more indicative of the relative observability of animals from year to year than of population trends. Counts along routes during 1961 indicated populations 10 to 20% higher than in 1960, whereas all other information indicated that 1961 summer numbers were at best subequal to those of the previous year and that the 1961–1962 winter–spring population was 10 to 20% lower. Indicated numbers for winter and spring, 1962–1963, were 25 and 50% lower than 1961–1962 despite evidence indicating quite similar population levels. The influence of observability was further evidenced by variation in the magnitude and direction of seasonal changes in observed numbers, indicating that similar proportions of the mule deer present were not seen in any given season of the different years, and the fact that observed numbers did not fully reflect the population increase which occurred in 1963. Also, average numbers observed per trip from 1960 to 1962 when animals were relatively observable corresponded closely to numbers observed on open ridgetop sites, whereas data for the 1962–1964 period were similar to numbers observed in predominantly coulee areas.

Although trends in utilization and condition of forage will be discussed later, it should be noted here that both these and the foregoing population data indicated that mule deer probably contended with forage deficiencies and intraspecific competition during most years.

Elk

Although elk occurred extensively in the Missouri River Breaks as late as the 1870's (Koch 1941:363–365), few if any remained in the area by the time of settlement in the early 1900's. The existing population developed following the release of 31 animals (22 adult females, 6 calves, and 3 adult males), transplanted from Yellowstone National Park, on the south-central portion of the present study area during February 1951. No data on growth of the population were obtained prior to 1959 when District Game Manager Reuel G. Janson (pers. comm.) estimated 80 elk on the area prior to a special hunting season to alleviate damage on private lands.

TABLE 6.—MAXIMUM UNDUPLICATED COUNTS OF ELK ON THE MISSOURI RIVER BREAKS STUDY AREA DURING WINTERS 1960–1964

Year	Total No.	No. Males		No. Females	No. Calves	Calves: 100 Females	Males: 100 Females
		Adult	Yearling				
1960-1961	70	8	10	32	20	62	56
1961-1962	80	9	13	41	17	42	54
1962-1963	108	12	13	54	29	54	46
1963-1964	108	13	9	51	35	69	43

The elk on the study area during the 1960–1964 period (Table 6) did not comprise a discrete population. Undetermined numbers occurred on adjacent areas during all years. Year-to-year relationships of numbers in the various sex and age classes on the study area indicated interchange of animals between the study area and adjacent ranges. The mean net recruitment to the population, based on observed population structures, calf production (Table 6), and known losses, was approximately 35% during the 4 years. Assuming a similar rate of increase in years prior to the study, a much larger population could have existed. It seemed unlikely, however, that actual numbers using the study area were greatly in excess of those counted. Either mortality was of greater than observed proportions or emigration from the area provided effective control over population growth.

Trends in numbers of elk on the study area during other seasons appeared similar to those of winter. Spring populations seemed somewhat lower than those of the previous winters. Summer numbers apparently were less than those of the subsequent fall and winter when some movement onto the study area seemed to occur. Known losses during the fall ranged from 2 in 1962 to 11 during 1961. No legal hunting of elk occurred during the study.

Cattle

Fourteen stockmen held permits to graze 1,646 cattle (plus calves) on the common, open range allotment encompassing the study area and adjacent prairie (B.L.M., Lewistown, Montana, pers. comm.). Of these, 11 with 1,205 permits ran their stock largely on the study area; 2 with 166 permits partially used the area; and 1 with 175 permits usually did not graze the area.

Actual numbers of cattle on the study area varied considerably within and between years, some proportion of the total always ranging onto immediately adjacent areas. This number appeared to increase from spring to summer, then decreased slightly to fall. Greatest cattle use of the study area occurred during the spring and summer of 1961 when most operators turned their stock into the "Breaks" where forage and water conditions were somewhat better than on adjacent prairies. Lowest use occurred during the fall, and during the spring of 1962 when most operators delayed turning their stock onto the range until early May.

RANGE USE

Mule Deer

A total of 11,581 mule deer observations provided data for evaluation of mule deer range-use habits. These were recorded by year as follows: 1960–1961, 5,577; 1961–1962, 3,431; 1962–1963, 1,797; and 1963–1964, 776.

Distribution

The mule deer were nonmigratory and widely dispersed over the study area, though local population densities varied (Fig. 16). Maximal numbers occurred on the south-central portion where close interspersion of well-developed stands of *Pinus–Juniperus* and *Pseudotsuga–Juniperus* with other habitat types provided a relatively high security level. Lowest densities prevailed north and west of Sand Creek. Al-

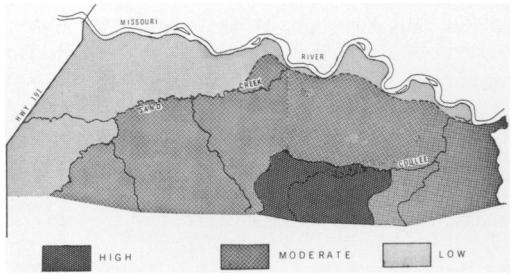

FIG. 16. Highly generalized distribution of densities of mule deer on the Missouri River Breaks study area for 1960–1964.

though differences related to topography and vegetation influenced observed numbers, averages of 15.0 and 11.0 mule deer, respectively, were recorded per observation trip along routes in those areas.

The only distinct seasonal shift in distribution during the study consisted of movement onto Missouri River bottomlands during summer and fall as forage supplies on uplands became desiccated. It appeared to involve only animals from adjacent slopes and possibly uplands within about 2 miles of the river. Mule deer were rarely observed on bottomlands after early December. Aerial surveys during late December 1964, after regular field studies were completed, indicated a general movement of deer from major drainageheads toward steep open slopes on northern portions of the area. This movement apparently was precipitated by snow depths of 15–24 inches, unlike any of the previous 4 winters, and had rather severe population consequences (Mackie 1966b).

The increase in numbers of mule deer observed along extensive ridgetops during winter and early spring (Fig. 15) probably was a reflection of local movement and increased observability concomitant with seasonal changes in food and range-use habits. Numbers of mule deer recorded in predominantly coulee areas increased simultaneously.

Males appeared less uniformly distributed than females, especially during summer and early fall when single males or groups of 2 to 5 (occasionally more) animals, mostly 2 years old and older, appeared to congregate on the same nondescript local areas. At least 25 such "buck habitats" were known for the study area. During summer, an average of 1.66 males was observed per trip through "blocks" which partially or entirely encompassed male concentration areas. Only 0.24 males, mostly yearlings, were observed per trip through blocks in other areas.

Movements and Home Ranges

Sixteen mule deer fawns were individually marked using various combinations of colored plastic tape and 2 × 3-inch flags of nylon impregnated fabric (Saflag Fabric, the Safety Flag Co. of America, Pawtucket, R.I.) attached to an ear. Four were never relocated; 3 were last observed about 1 month after birth; and 9 were individually relocated from 2 to 21 times over periods of 5 to 29 months after tagging. Five individually recognizable mule deer, 1 fawn and 4 adult males, were observed 2 to 5 times over periods of a day to 4 months.

A summary of movement data for all marked and recognizable animals other than fawns observed only when less than 6 months old is presented in Table 7. Home ranges of females encompassed approximately 300 acres. Males were somewhat more mobile and may have had larger home ranges; but few quantitative data were obtained, especially for males older than 2 years.

Greater mobility of mule deer males has been reported by Dasmann and Taber (1956:153), Robinette (1966:337), and others. Relocations of three marked males to 16, 20, and 21 months of age indicated movements through the second summer were comparable to those of females, as reported by Dasmann and Taber (1956: 155). Subsequently, movements became more extensive during fall and winter resulting in enlargement or establishment of new home ranges. Older males appeared to have greater mobility and larger home ranges.

Home ranges of marked females were established by the second summer and were

TABLE 7.—MOVEMENTS OF MARKED AND RECOGNIZABLE MULE DEER IN THE MISSOURI RIVER BREAKS. MAXIMUM DISTANCES FOR ANIMAL NUMBER D-1853 MAY HAVE BEEN INFLUENCED BY HUNTERS. ANIMAL NUMBER D-1859 HAD MOVED ONLY 0.43 MILE AT 13 MONTHS; THE ADDITIONAL MOVEMENT OF 1.5 MILES OCCURRED AT ABOUT 17 MONTHS

Animal	Age at First Observation	Dates of Observation	Number of Observations	Distance (Miles)				Estimated Home Range (acres)
				Maximum between Observ.	First to Last Observ.	From Center of Range		
						Mean	Maximum	
Female (D-1853)	1 day	6/61–11/63	21	1.59	0.28	0.39	1.00	300
Female (D-1851)	11 months	5/61–10/63	22	1.25	0.65	0.32	0.65	320
Male (D-1864)	4–5 days	6/62–3/64	10	1.09	0.93	0.38	0.62	400
Male (D-1859)	2–3 days	6/62–2/64	4	2.75	2.75	—	—	—
Male (D-1869)	8 months	2/63–10/63	5	0.90	0.59	0.43	0.53	300
Fawn (Recog.)	7 months	1/61–5/61	5	0.34	0.18	0.11	0.18	—
Male (Recog.)	19 months	1/62–3/62	3	1.00	1.00	0.45	0.59	—
Male (Recog.)	Adult	5/61–9/61	2	0.87	0.87	—	—	—
Male (Recog.)	Adult	9/61	2	0.84	0.84	—	—	—
Male (Recog.)	Adult	3/62–7/62	2	2.00	2.00	—	—	—

partially superposed on those of parent females. Considerable variation was evident among males. One (D-1864) ranged over an increasingly larger area immediately adjacent to its home range as a fawn, at least until 21 months of age; another (D-1869) remained within the same general area on which it had been observed as a fawn until at least 16 months old; and the third (D-1859) was observed during the second summer on a male concentration area 0.4 mile from the tagging site and subsequently moved 1.5 miles during November to an entirely new area. These differences may have been influenced by social relationships during the second summer. The 3 associated with another young male, an adult female and fawns, and an older adult male, respectively.

Differentially greater seasonal use of certain portions of home ranges was evident between seasons and years. Predominant use typically occurred on brushy or timbered portions on one side during summer and on open ridgetop sites on the other side in winter. However, one of the marked females (D-1853) ranged extensively on the open ridgetop portion of her home range during the fall and winter of 1961–1962 but apparently remained in the vicinity of the more timbered portion during most of the winter of 1962–1963. Both marked females appeared to return to the same portion of the home range where they were born to give birth to fawns. One was observed during the fawning periods of 1962 and 1963 in the same locality where tagged, and one of the twin fawns of the other was tagged when 1 day old within a few yards of where the female had been tagged as a day-old fawn.

Mule deer food preferences and the quantity and quality of available forage appeared to be primary factors influencing local and seasonal movements within home ranges. Observations suggested that movement was most restricted during the summer, then increased to winter or early spring as food habits changed to include greater representation of species from the open *Artemisia–Agropyron* habitat type. That is, greater effort became necessary to satisfy nutritional requirements as the quantity and quality of available forage declined. The importance of the latter was indicated by yearly contrasts in movement with variations in production and seasonal utilization of preferred species. In 1960, forage production was subnormal, summer–fall utilization of deciduous browse species was heavy, and local movements increased appreciably to winter and early spring. During 1961, forage production was extremely low as a result of drought conditions, summer uti-

TABLE 8.—SUMMER AND FALL MOVEMENTS OF MARKED MULE DEER FAWNS IN THE MISSOURI RIVER BREAKS

Period	Number of Fawns	Number of Relocations	Mean Distance (Miles)		Maximum Between Relocations
			From Tag Site	First to Last Relocation	
June–August	6	13	0.20	0.22	0.53
September–November	4	8	0.57	0.72	0.72

lization of deciduous browse was extremely heavy, and seasonal changes in food habits occurred much earlier than in 1960. Also, fall rainfall resulted in a green-up of Sandberg bluegrass and junegrass which concomitantly became important forage sources on open habitat types. The combined effects were reflected in more extensive movement during all seasons. During 1962–1963, favorable growth conditions effected good forage production. Supplies of preferred forbs persisted into fall and winter, summer utilization of deciduous browse was light to moderate, and local movements appeared extremely restricted with only slight increase to winter and early spring.

The presence of fawns, whose maximum summer movements were limited to areas about 0.5 mile in diameter, may have influenced mobility of adult females (Table 8). However, general observations suggested that females usually foraged independently until mid-August, and females without fawns were equally restricted in movement during the summer period.

Group Characteristics

Mule deer groups ranged in size from 1 to 25 animals, but the most common numbers were near seasonal means (Table 9).

Groups typically were smallest in summer when mule deer were relatively dispersed and using a variety of habitat types. Those of more than 4 or 5 animals were almost invariably males. Aggregation occurred slowly through fall and winter, concomitant with increasing use of open habitat types and/or concentration on certain sites. Usually, the largest groups were observed in late winter and early spring. This increase in seasonal group size apparently reflected more strongly a greater incidence of association on mutually used areas than changes in social relationships. Support for this statement was provided by observations that the composition of groups associated with recognizable animals changed frequently. The number of mule deer in a group reflected the locations within home ranges of individuals on overlapping home ranges.

Group sizes were somewhat larger in 1961–1962 than in other years. Possibly, this was related to more concentrated use of certain habitat types. Group sizes in general decreased in subsequent years as the animals remained more widely dispersed.

Activity Habits

Mule deer typically were active and observable mostly within 3–4-hr periods in early morning and late afternoon. They appeared more active during mornings

TABLE 9.—MEAN GROUP SIZE FOR MULE DEER OBSERVED DURING SEASONS AND YEARS 1960–1964. NUMBERS OF MULE DEER IN SAMPLES ARE IN PARENTHESES

Year	Summer	Fall	Winter	Spring	Year
1960–1961	1.5 (731)	2.5 (734)	3.7 (1,441)	4.4 (2,671)	3.1
1961–1962	1.5 (669)	2.8 (587)	5.2 (845)	5.0 (1,330)	3.2
1962–1963	1.5 (483)	2.4 (163)	4.0 (526)	3.8 (625)	2.6
1963–1964	1.6 (373)	2.5 (163)	3.5 (120)	5.7 (120)	2.2
1960–1964	1.5	2.6	4.1	4.5	3.0

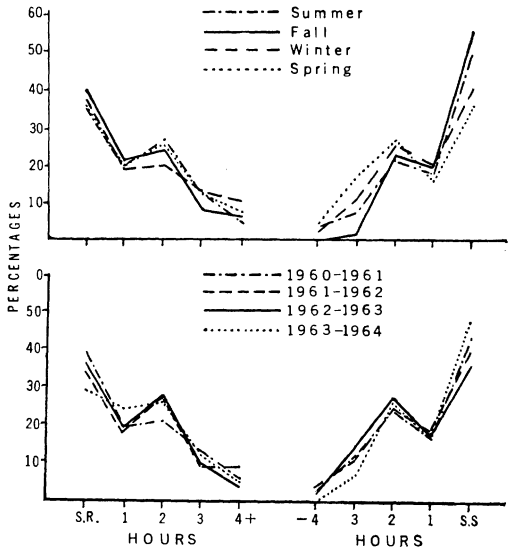

FIG. 17. Percentages of all mule deer observed each hour relative to sunrise and sunset during seasons and years.

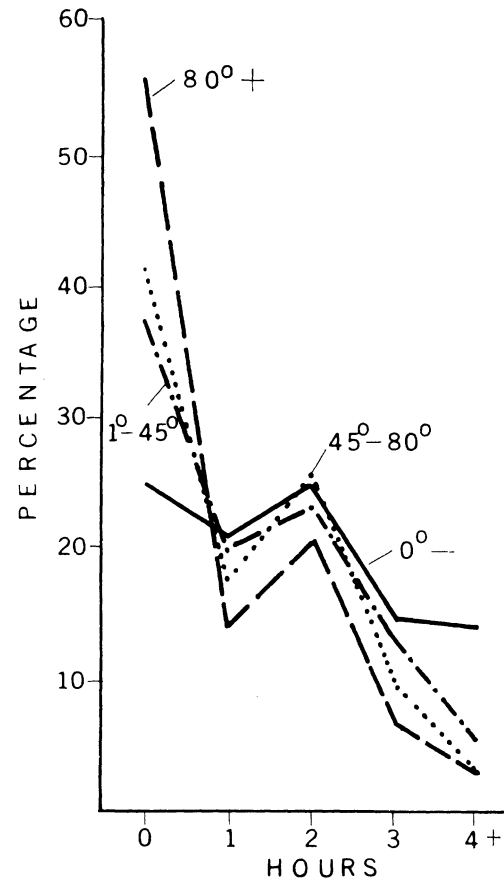

FIG. 18. Percentages of all mule deer observed each hour relative to sunrise and sunset in relation to ambient temperatures. Data are for morning and evening activity periods combined.

when an average of 26 animals was recorded per observation trip, compared to 19 per trip during evening, and "activity periods" were slightly longer. Greatest numbers were observed during the first and last hours of daylight, with 75% or more of all observations usually occurring within 2.5 hr after sunrise and before sunset and more than 90% within 3.5 hr. Percentage distributions for morning, evening, seasonal, and yearly periods (Fig. 17) were similar despite differences in numbers of animals observed, range forage conditions, weather conditions, as well as mule deer densities, food and range-use habits, and behavior. These factors generally caused variation only within the normal activity periods.

The prolonged activity periods of late winter and early spring reflected more nearly equal distribution of observations through normal activity periods and some extended feeding later in the day. These phenomena were most pronounced under the extremely poor range forage conditions which prevailed during 1961–1962. The short periods of fall were characterized by concentration of activity in the first and last hours of daylight and sharply decreased activity later in the day, except during the fall of 1961 when activity was prolonged in a distribution similar to that of winter. A trend toward a fall-like distribution during all seasons occurred after the spring of 1962 as range forage conditions improved and mule deer became increasingly wary.

The distribution of activity during normal activity periods varied with temperature. The proportions of the total mule deer observed during the first and last hours of daylight increased as temperature increased (Fig. 18). The most significant differences were associated with subzero temperatures, when only 25% of the animals were observed during the first and last hours of

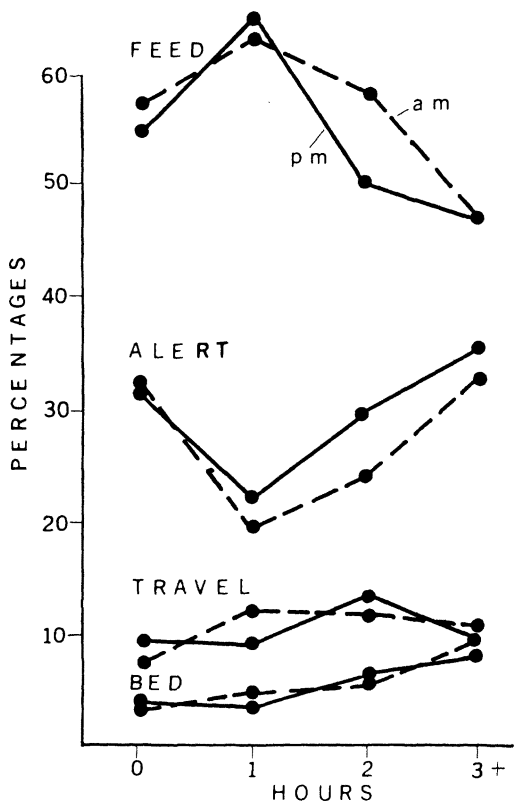

FIG. 19. Percentages of all mule deer observed in different activities each hour after sunrise (AM) and before sunset (PM).

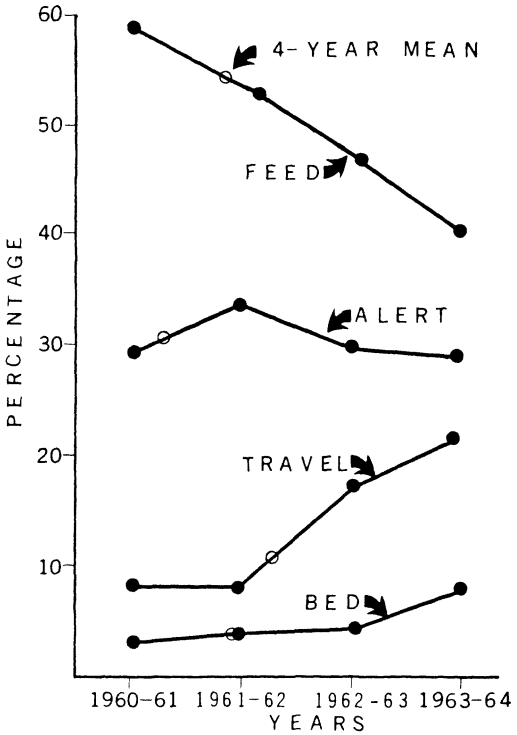

FIG. 20. Percentages of all mule deer observed in different activities each year.

daylight and approximately 30% of all observations were recorded more than 2.5 hr after sunrise and before sunset and with temperatures above 80 F, when nearly 60% and less than 10%, respectively, of all observations occurred during those periods. Other weather factors undoubtedly influenced variation but significant effects were obscured by interactions.

Feeding was the predominant activity recorded for mule deer observed during all hours of activity periods (Fig. 19), seasons, and years (Fig. 20). The hour of most intensive feeding was between 0.5 and 1.5 hr after sunrise and before sunset (Fig. 19). Decreased movement associated with this may have influenced the characteristic decrease in numbers of animals observed during that time (Fig. 17). That type of activity influenced observability was further illustrated by the small differences in proportions observed bedding through activity periods. Numbers observed differed greatly.

The decrease in proportions of mule deer observed feeding and the complementary increase in traveling during the 4 years (Fig. 20) can be interpreted as an increase in wariness. This was particularly apparent along roads on major ridges. These changes appeared correlated with hunting pressures during 1960–1962 suggesting selective removal of less wary animals from the previously lightly hunted population or that mule deer became increasingly responsive to disturbance.

Use of Habitat Types

Data showing the relative seasonal and yearly use of different habitat types by mule deer are presented in Table 10. Monthly

TABLE 10.—PERCENTAGES OF TOTAL MULE DEER OBSERVED IN ALL ACTIVITIES (A) AND FEEDING ONLY (F) ON RANGELAND HABITAT TYPES IN THE MISSOURI RIVER BREAKS, MONTANA, 1960–1964. TRACE (T) AMOUNTS ARE LESS THAN 1%

Season Year	Number of Deer Observed	*Artemisia–Agropyron* A/F	*Agropyron–Poa* A/F	*Pinus–Juniperus* A/F	*Pseudotsuga–Juniperus* A/F	*Artemisia longifolia* A/F	*Sarcobatus–Agropyron* A/F	*Agropyron–Symphoricarpos* A/F	*Xanthium strumarium* A/F
Summer									
1960	731	37/36	T/T	48/40	4/5	2/2	4/5	4/6	2/5
1961	669	30/34	T/T	44/34	13/14	T/T	7/9	4/6	T/2
1962	483	22/23	T/1	54/53	12/10		10/11	2/2	T/T
1963	373	20/21	T/0	46/45	23/25	2/T	6/5	3/4	T/T
4-Year Total	2,256	29/31	T/T	48/41	11/11	T/1	6/8	3/5	1/2
Fall									
1960	734	48/48	3/6	29/23	9/8	1/2	4/2	6/10	T/1
1961	587	35/35	4/6	34/31	7/4	3/3	10/12	4/6	1/1
1962	163	29/22	T/0	40/40	12/12		16/26	2/0	
1963	163	22/12		41/36	25/34	4/7	6/5	3/6	
4-Year Total	1,647	39/37	3/5	33/29	10/9	2/3	8/8	4/7	T/1
Winter									
1961	1,441	58/64	T/T	28/22	2/2	T/T	10/10	T/0	
1962	845	60/74		32/22	T/0		8/4		
1963	526	43/60		42/33	5/5		10/2		
1964	120	63/79		30/11	4/4		2/6		
4-Year Total	2,932	56/67	T/T	32/24	2/2	T/T	9/8	T/0	
Spring									
1961	2,671	78/82		17/12	T/T		4/5	1/1	
1962	1,330	62/72	2/T	26/19	1/1	T/T	7/5	1/T	T/T
1963	625	52/52	T/T	27/21	4/2	3/4	12/19	T/2	T/T
1964	120	67/100		27/0	4/0		2/0		
4-Year Total	4,746	70/76	T/T	21/14	1/T	T/T	6/6	1/1	T/T
Yearlong									
1960-1961	5,577	63/68	T/T	25/18	2/2	T/T	6/6	2/3	T/T
1961-1962	3,431	51/60	1/1	33/24	4/4	T/T	8/7	2/2	T/T
1962-1963	1,797	39/45	T/T	40/34	7/6	1/1	11/12	T/1	T/T
1963-1964	776	34/38	T/0	39/31	18/21	2/2	5/4	2/3	T/T
4-Year Total	11,581	54/61	T/T	31/23	5/4	T/T	7/7	2/2	T/T

trends in occurrence on types which accounted for 10% or more of the total observations for at least 1 month are shown in Figure 21.

Summer (June, July, August).—*Pinus–Juniperus*, a major type, received maximum use and was the single most important habitat type during summer. Among the 3 communities comprising this type, the *Pinus–Agropyron* association appeared to be most important, especially for feeding. Greatest use on the *Pinus–Juniperus* and *Pinus–Artemisia* associations occurred in early summer, though the former was important for bedding and escape cover throughout the period.

Use on the extensive *Artemisia–Agropyron* type ranked second overall and for 3 of the 4 summers. This was predominantly on the *Artemisia–A. smithii* associes and the *Artemisia–A. smithii* association along the edge of timbered types and on smaller ridgetops. Many forbs preferred for food during the period were members of the *Tragopogon* union which was best developed in these communities.

Observed usage of the moderately extensive *Pseudotsuga–Juniperus* type ranked third overall and for 3 of the 4 summers.

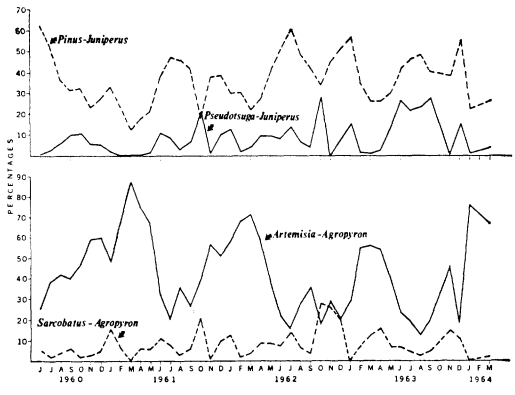

FIG. 21. Monthly frequencies of mule deer on habitat types receiving more than 10% of the total observed use during at least one month.

Although greatest numbers of deer typically were observed on this type in June during fawning, it provided important bedding and escape cover throughout the summer. The low use in 1960 may have been due in part to confusion of some fir sites with pine communities early in the study. Because stands of *Pseudotsuga–Juniperus* generally were dense, making observations difficult, the type may have received much greater use than recorded.

Relatively few deer were observed on other habitat types. Occasionally, as in 1960, abundance of preferred forbs on the *Agropyron–Symphoricarpos* and *Xanthium* types attracted intensive use despite their restricted distribution and small total acreages.

Fall (September, October, November).—Relative use of the two major types, *Artemisia–Agropyron* and *Pinus–Juniperus*, during fall varied in importance over the years. The former received the highest percentage of use overall and in 1960. Occurrence of mule deer was approximately equal on the two types for 1961 and predominated on *Pinus–Juniperus* during 1962 and 1963. Use of individual communities also differed slightly from summer, especially on the *Artemisia–Agropyron* type where activity became concentrated on the *Artemisia–A. smithii* association. This appeared to be related to utilization of rubber rabbitbrush and occasionally Sandberg bluegrass. Both plants were relatively abundant in the community. Although the *Pinus–Agropyron* association remained the most important community of the *Pinus–Juniperus* type, the *Pinus–Artemisia* association was used rather extensively during mid-September when longleaf sagebrush was briefly important as a food source. It later received only very minor use as did the *Pinus–Juniperus* association.

Overall use of other habitat types was minor; although for some (e.g., *Agropyron–Poa*) use in fall was greater than in summer, and *Pseudotsuga–Juniperus* received especially intensive use in the fall of 1963.

Winter (December, January, February).—Greater numbers of mule deer were recorded on *Artemisia–Agropyron* than any other type for all winters except 1963 when use of the *Pinus–Juniperus* type was comparable. Percentages observed on the *Artemisia–Agropyron* type increased monthly, reflecting increasing mule deer dependence on big sagebrush and associated taxa as the availability of preferred or "variety" forage plants decreased on other habitat types. The *Artemisia–A. smithii* associes and the *Artemisia–A. smithii* association remained the most important communities. Increased use of the latter through the winter probably was influenced by the greater abundance of big sagebrush, rubber rabbitbrush, and Hood's phlox, *Phlox hoodii* Rich., which was an important food item when available; but also, the heavily grazed, extensive open ridgetops occupied by this association held less snow.

The *Pinus–Juniperus* type ranked second in winter usage. Most intensive use on the type occurred during and for a few days after winter storms. A large percentage of the feeding usage was associated with movement to and from bedding sites or with utilization of Rocky Mountain juniper. The *Pinus–Agropyron* association was again the most important community, but the *Pinus–Juniperus* association occasionally received heavy use during periods of snow or extremely cold weather.

Sarcobatus–Agropyron, the only other type of any consequence to mule deer during winter, received minor use. This occurred mostly during December and January and was predominantly on steeper slopes locally dominated by the type in contrast to earlier use largely on coulee bottom sites. The *Pseudotsuga–Juniperus* type, restricted to windswept, snow-retaining, northerly exposures, received only very minor use; most was along upper margins of the type, transitory, or during mild, open periods. Deer were rarely observed on other habitat types during winter.

Spring (March, April, May).—The *Artemisia–Agropyron* type received the greatest use throughout the period but was used most intensively during late March and early April concomitant with the appearance of green plants. Early spring activity was centered upon the *Artemisia–A. smithii* association, and appeared related to the prominent *Poa* union which was an important source of mule deer forage during the period. The relative use and importance of the *Artemisia–Agropyron* type declined sharply after mid-April as forage became increasingly available on other types.

Use of the *Pinus–Juniperus* type was relatively minor until about mid-April, then increased rapidly until late May when observed use was comparable to summer. The *Pinus–Agropyron* association received the greatest use, though numbers of mule deer observed on the *Pinus–Juniperus* association increased considerably after new growth appeared on shrubs.

Sarcobatus–Agropyron was the only other habitat type to receive appreciable spring use. Most of this appeared related to utilization of Sandberg bluegrass and associated forbs which were well represented on coulee bottom sites.

Discussion.—The results indicated significant trends in mule deer relations to habitat types. *Pinus–Juniperus*, a major type, received maximum usage and was the single most important type during summer. Relative use of this, as well as the moderately extensive *Pseudotsuga–Juniperus* type, declined slowly through fall, the latter becoming relatively unimportant except as escape cover by early winter. Though generally declining in use, the *Pinus–Juniperus* type remained moderately important for feeding and most important for bedding and escape until early spring. Use of both types increased rapidly to summer levels during late spring. Relative use and importance of *Artemisia–Agropyron*, the other major type, was lowest during the summer, generally increased through fall, and became of major importance during early winter. The most extensive use occurred in early spring when it was by far the most important habitat type for feeding. The rather minor *Sarcobatus–Agropyron* type received minor use during all seasons, while the *Agropyron–Symphoricarpos* type was of some importance during summer and fall but little used during other periods. Other habitat types were very minor both in extent and mule deer use.

To evaluate possible bias resulting from greater observability of animals on open habitats, "observability indices" were calculated (average number of deer recorded per observation trip ÷ approximate average number which might have been recorded if all deer present had been observed) for each season. The "expected" average numbers were determined for each season on the basis of average numbers recorded per trip during the spring of 1961, when maximum numbers of mule deer were observable, and yearly population trends. Observability indices ranged from 13.2% during the fall of 1962 to 100% during spring seasons of 1961 and 1962. Averages by season were: summer, 16.6; fall, 19.3; winter, 47.2; and spring, 74.4. The low values for summer and fall suggested that use of the brushy or timbered *Pinus–Juniperus* and *Pseudotsuga–Juniperus* habitat types may have been much more intensive than observations indicated and that relative use of *Artemisia–Agropyron*, which ranked high in observations for all seasons, was minor. Observability during winter was much increased over summer and fall. Although greater than indicated use probably oc-

TABLE 11.—PERCENTAGES OF TOTAL MULE DEER OBSERVED ON SLOPES OF VARYING DEGREES OF STEEPNESS DURING SEASONS AND YEARS 1960–1964

Season	Sample Size	Degrees of Slope			
		0–10	11–25	26–35	36+
Summer	2,256	41.4	24.4	22.5	11.7
Fall	1,647	49.2	23.8	16.9	10.0
Winter	2,932	49.6	21.8	17.9	10.7
Spring	4,746	64.4	19.9	11.8	3.8
1960–1961	5,577	59.1	20.6	13.3	7.1
1961–1962	3,431	50.8	23.3	16.2	9.6
1962–1963	1,797	45.7	22.3	23.2	8.8
1963–1964	776	50.5	23.0	20.8	5.6
1960–1964	11,581	54.0	21.8	16.2	7.9

curred on the *Pinus–Juniperus* type, it seemed unlikely that the difference was significant enough to alter conclusions as to the relative importance of the various types. Mule deer typically were highly observable during early spring, and observations, particularly for 1961 and 1962, probably reflect the actual relative intensities of use on the various types more closely than any other period.

Variations in occurrence of mule deer on the different types of habitat between seasons and years corresponded closely to changes in the availability of preferred forage. The prominence of the *Artemisia–Agropyron* type during 1960 and 1961 appeared related to excessive utilization of preferred deciduous browse on timbered types under drought conditions and high numbers of mule deer. The most significant changes, occurring after the spring of 1962, were related to increased growth of forbs, especially yellow sweetclover. Use of these plants by mule deer decreased utilization of preferred browse during summer resulting in persistent availability of forage on all habitat types through fall and winter.

Weather conditions also influenced use on the different types. Greater percentages of the total deer observed were in timbered types at temperatures below 0 F and above 80 F than with more moderate temperatures for summer and winter, respectively. Use of the *Artemisia–Agropyron* and *Agropyron–Poa* types decreased progressively with wind velocities above 10 mph. During winters, the *Pinus–Juniperus* type was used most intensively during periods of complete snow cover.

Use of Slopes

Approximately 50% of the mule deer were observed on slopes of 11° or more but few animals were observed on slopes steeper than 45° (Table 11). Steeper slopes were used during summer reflecting the predominant use of timbered types of habitat. The animals were concentrated on level to gently sloping sites during late winter and early spring when primarily using the *Artemisia–Agropyron* type. The variation between years was related to differences in use of habitats.

Use of Exposure

Numbers of mule deer on slopes (Table 12) appeared to reflect relative use and

TABLE 12.—PERCENTAGES OF MULE DEER OBSERVED ON SLOPES OF VARIOUS EXPOSURE DURING SEASONS AND YEARS 1960–1964. PERCENTAGES ARE OF TOTAL OBSERVED ON SLOPES STEEPER THAN 10°

Season	Sample Size	% on 0–10° Slope	Exposure							
			N	NE	E	SE	S	SW	W	NW
Summer	2,256	41.4	16.4	13.5	9.3	10.3	20.3	15.3	9.0	5.7
Fall	1,647	49.2	20.6	14.5	9.8	4.4	20.4	13.7	4.7	7.8
Winter	2,932	49.6	18.7	8.0	7.3	12.9	29.1	14.3	6.2	3.0
Spring	4,746	64.4	11.4	13.6	12.9	15.6	17.3	14.2	9.1	5.9
1960–1961	5,577	59.1	19.3	12.9	9.7	14.4	18.7	13.3	6.4	5.1
1961–1962	3,431	50.8	14.8	10.8	8.9	9.8	27.2	16.2	6.9	5.6
1962–1963	1,797	45.7	9.3	11.7	12.2	11.4	26.3	14.0	10.1	4.8
1963–1964	776	50.5	19.8	15.8	11.5	5.1	13.9	14.7	12.0	7.2
1960–1964	11,581	54.0	16.1	12.2	10.0	11.7	22.4	14.4	7.6	5.4

TABLE 13.—PERCENTAGES OF TOTAL MULE DEER OBSERVED AT ONE-FOURTH-MILE INTERVALS FROM KNOWN WATER SOURCES DURING SEASONS AND YEARS 1960–1964. TRACE (T) AMOUNTS ARE LESS THAN 1%

Season	Year	Sample Size	Distance Class in Miles								
			0–¼	¼–½	½–¾	¾–1	1–1¼	1¼–1½	1½–1¾	1¾–2	>2
Summer	1960	731	37.3	38.2	17.6	4.8	1.1	T	T		
	1961	669	22.1	22.9	20.2	10.9	8.5	9.0	4.3	2.1	
	1962	483	8.7	21.3	28.8	18.0	8.1	9.5	5.4	T	
	1963	373	17.0	19.1	24.5	17.8	8.2	9.0	4.3		
Total	1960–1963	2,256	23.3	26.9	21.9	11.6	6.0	6.4	3.2	T	
Fall	1960	734	33.0	29.6	16.5	9.8	7.4	3.0	T		
	1961	587	31.3	33.6	14.5	10.2	4.1	2.7	3.6		
	1962	163	7.4	18.4	36.8	16.0	8.6	5.5	3.1	4.3	
	1963	163	4.3	20.2	33.1	18.4	5.5	10.4	2.5	4.3	1.2
Total	1960–1963	1,647	27.0	29.0	19.4	11.4	6.1	3.9	2.2	T	T
Winter	1961	1,441	11.0	22.1	30.1	20.6	8.5	3.5	2.0	2.2	
	1962	845	37.5	21.3	17.5	16.0	3.2	1.9	2.1	T	
	1963	526	9.3	28.5	23.4	15.8	10.5	7.6	4.4	T	
	1964	120	22.5		23.3	35.0	T	8.3	9.2	T	
Total	1961–1964	2,932	18.8	22.1	25.0	19.0	7.0	4.0	2.8	1.3	
Spring	1961	2,671	15.4	25.9	31.3	15.8	5.8	3.6	1.8	T	
	1962	1,330	14.7	21.7	29.6	18.9	7.8	4.4	2.0	T	
	1963	625	10.4	23.6	32.3	21.2	6.5	4.3	1.6		
	1964	120	22.5	15.8	30.0	10.0	8.3	13.3			
Total	1961–1964	4,746	14.7	24.2	30.9	17.3	6.6	4.2	1.7	T	
Yearlong	1960–1961	5,577	19.4	27.0	27.3	14.8	6.1	3.1	1.5	T	
	1961–1962	3,431	24.6	23.8	22.2	15.2	6.2	4.4	2.7	T	
	1962–1963	1,797	9.3	24.0	29.1	18.3	8.3	6.8	3.6	T	
	1963–1964	776	16.0	15.9	27.0	19.4	6.5	9.9	4.0	1.0	T
Total	1960–1964	11,581	19.2	24.9	26.0	15.8	6.5	4.5	2.4	T	T

observability on the *Pinus–Juniperus* and *Pseudotsuga–Juniperus* types and the relative amount of area having each exposure more than distinct seasonal preferences. South-, southwest-, and north-, and northeast-facing slopes were generally most extensive on the area. South-facing slopes seemed to receive more use during all seasons, especially winter. Increased use of northerly exposures during fall may have been related to thicker cover. The subsequent decrease in winter and spring was influenced by snow and wind.

Relations to Water

The relative percentages of observations at various distances from water (Table 13) indicated that use of range by mule deer decreased sharply at distances of a mile or more. Most observations, especially during summer and fall when "permanent" water sources would be most important, were within 0.75 mile of a water source. The number of observations at greater distances decreased as distance increased, with negligible use at 2 miles or more.

The distances from water at which mule deer were observed generally reflected the distribution of water sources in relation to areas used by the animals during different seasons and years. In 1961, when water sources were at a minimum, the percentage of mule deer observations within 0.5 mile of water decreased and the number at greater distances increased as compared to 1960. Most reservoirs were along the periphery of larger ridgetops. Thus, relative intensities of use of the *Artemisia–Agropyron* type during seasons and years, rather than distance, determined the relationship between locations of mule deer observations and water supplies. From this I concluded that the distribution of water on the study area even during the most arid years

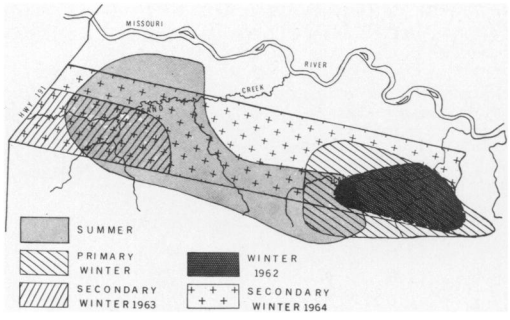

FIG. 22. Summer and winter distributions of elk on the Missouri River Breaks study area, 1960–1964.

was not a significant factor in determining mule deer distribution.

Elk

The smaller number, irregular distribution, and gregarious behavior of elk was reflected in observations during only 280 trips (54% of the total) at the low frequency of 1.8 groups (12.4 individuals) per trip. A total of 3,489 elk observations, used in evaluating range-use habits, was recorded as follows: 1960–1961, 1,307; 1961–1962, 1,111; 1962–1963, 815; and 1963–1964, 256.

Distribution

The study area comprised the principal range of the elk population south of the Missouri River. Adjacent "breaks," especially west of the area, received variable but increasing use during the 4 years. Some unexplained movement across the Missouri River also occurred, possibly associated with feeding on bottomlands and the breeding season.

The elk were nonmigratory but differentially utilized various portions of the area during the year (Fig. 22). Vegetational complexes and the availability of preferred forage, as influenced by general range conditions, annual vegetational growth, and prior use, appeared to be the primary determinants of seasonal distributions and variations thereof. Physiographic and weather factors apparently were secondarily related. Variation in use of local areas within and between seasons and years corresponded closely to changes in distribution and intensity of grazing by domestic livestock.

The late spring and summer distribution (Fig. 22) coincided closely with the distribution of more extensive, well-developed stands of *Pseudotsuga–Juniperus*. Principal differences between years were those associated with use of local areas within the circumscribed area. Elk generally dispersed over all but the extreme eastern portion of the study area during early fall. Use of Missouri River bottomlands, which appeared to increase during the years of study, occurred largely during this period. Concentration began in late October or early November. In 1960, 1961, and 1962, a majority of the animals congregated in the vicinity of cattle winter pastures on the south-central portion of the study area. Significantly fewer elk utilized this area during 1963 when the population remained more dispersed, and a segment congregated in the vicinity of previously ungrazed pastures along the western boundary of the study area. Use of the south-central area generally ceased during early December when cattle were turned onto and/or snow covered the grass-dominated pastures.

Distributions of elk in winter (Fig. 22) encompassed portions of the area characterized by extensive stands of the more open habitats where grasses were prominently represented and there was little or no use by livestock. The southeastern portion, much of which was only lightly grazed by cattle, was used almost exclusively during the winters of 1960–1961 and 1961–1962. During the latter, elk were observed largely on the central part where, with above-average range conditions, the extreme drought had minimal influence on the quantity of forage available. Elk were more dispersed during the winter of 1962–1963, evidently in response to the increased availability of forage on much of the area. Although most elk utilized the southeastern area in a distribution similar to the winter of 1960–1961, some use occurred on the western portion of the study area which had received little or no prior livestock use. Forage conditions

were generally excellent throughout the area during the winter of 1963–1964. The elk remained relatively widely dispersed with about one-third of the population wintering largely off the study area west of Highway 191.

The rather abrupt dispersal from the winter range during late March coincided approximately with the onset of the spring green-up. Most of the animals shifted directly to the summer range. Use of local areas during early spring appeared inversely related to range conditions and directly related to the degree of prior livestock use. This undoubtedly reflected the seasonal elk preference for Sandberg bluegrass, junegrass, and early spring forbs which commonly were more abundant and more readily available on these sites.

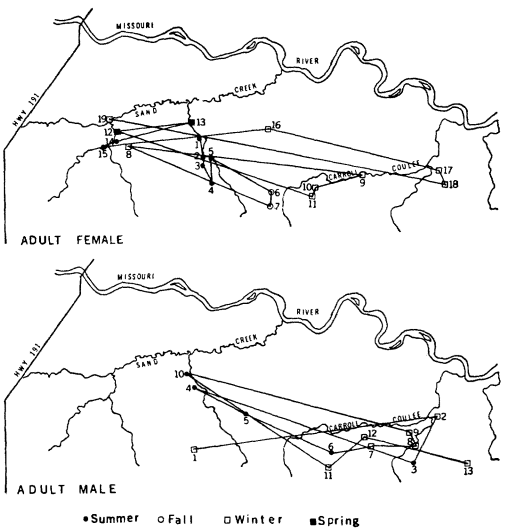

FIG. 23. Movements of a young adult cow elk from July 1962 to December 1964 and of an old adult bull elk from January 1961 to December 1964.

Movements

Ten recognizable adults and 3 marked calves were individually relocated 2 to 19 times over periods of 1 day to 4 years (Table 14). Movements of 2 representative individuals, an adult female and an adult male, are illustrated in Figure 23.

The elk were highly mobile. During spring, summer, and fall, movement typically was erratic. There were variable periods of restricted movement on local areas broken by abrupt shifts involving more extensive movement. Constant "wandering" was characteristic of winter movement. In general, movement was most limited during summer and most extensive during late winter and early spring. Rapid, extensive movements occurred occasionally during all seasons. One cow–calf group moved more than 5 miles from morning to evening during summer; another traveled more than 7 miles overnight during winter. Maximum distances between any 2 relocations of a given individual were: adult female, 14.5 miles; calf, 7.0 miles; adult male, 13.2 miles; and yearling male, 11.6 miles. The extreme mobility apparently enabled elk to adjust rapidly to environmental changes and constantly utilize the most favorable portions of the range.

Group Characteristics

Observed groups ranged in size from 1 to 66 animals. Seasonal and yearly averages

TABLE 14.—SEASONAL AND ANNUAL MOVEMENT OF ELK ON THE MISSOURI RIVER BREAKS STUDY AREA. DATA FOR FALL WERE OBTAINED LARGELY DURING OCTOBER AND NOVEMBER WHEN ELK CONGREGATED ON THE SOUTH-CENTRAL PORTION OF THE AREA. NUMBERS OF RELOCATIONS ARE IN PARENTHESES.

Group Class	Sample Size	Mean Distance Between Relocations (Air Miles)				
		Spring	Summer	Fall	Winter	Year
Adult Female	4	4.3 (3)	2.0 (10)	1.8 (2)	6.1 (8)	3.7 (23)
Calf	4	3.3 (1)	2.2 (9)	1.8 (7)	6.4 (1)	2.4 (18)
Adult Male	2	6.7 (4)	1.6 (1)	7.3 (1)	3.0 (7)	3.3 (13)
Yearling Male	3	3.8 (4)	2.2 (2)	—	3.4 (8)	4.2 (14)
Cow-Calf combined	8	4.0 (4)	2.1 (19)	1.8 (9)	6.1 (9)	3.1 (41)
Total	13	4.9 (12)	2.1 (22)	2.4 (10)	4.3 (24)	3.4 (68)

(Table 15) varied in relation to social relationships and distributions of elk use on the area. The high average during the winter of 1961–1962 was associated with extreme concentration on the southeastern portion of the study area. That of the fall of 1962 was related to aggregation on winter pastures on the south-central portion during November. Single individuals and small groups were most common in late May and early June. Average groups were common only in midsummer and spring prior to the calving period. The largest and most variable group numbers occurred during fall and winter. Groups including more than 30 elk were rare aggregations associated with feeding or flight. The composition of groups associated with recognizable elk changed frequently during all seasons. Knight (1968, unpublished doctoral dissertation, University of Minnesota, St. Paul, Minnesota) reported a similar lack of group constancy in the elk of Sun River, Montana.

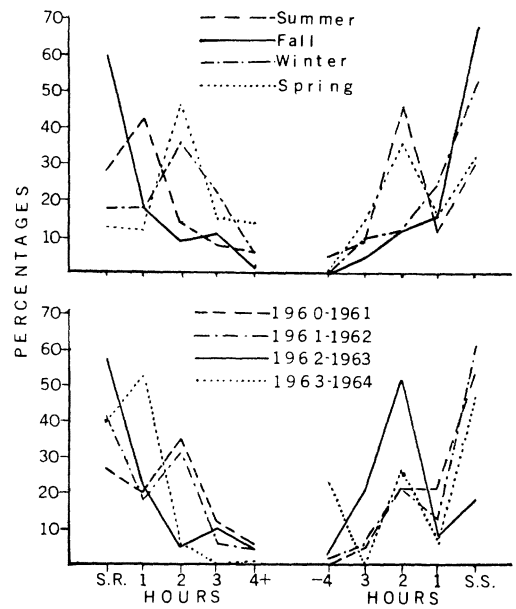

FIG. 24. Percentages of all elk observed each hour relative to sunrise and sunset during seasons and years.

Activity Habits

Like mule deer, elk were active mostly within 3–4-hr periods in early morning and late afternoon. Slightly greater numbers (58% of the total) were observed during mornings when an average of 15 elk was recorded per observation trip, compared to 10 per trip during evening, and activity periods were slightly longer. During the 4-year period, greatest numbers were observed during the first and last hours of daylight. Approximately 78% of all observations occurred within 2.5 hr after sunrise and before sunset, and 94% within 3.5 hr. Variation in the distribution of observations during normal activity periods for feeding elk is shown in Figure 24. The slopes of curves are exaggerated in some instances because of the concentrated nature of observations due to the gregarious habits and the distribution of elk. The consistency of "peaks" for the 2-hr category suggested a true relationship and that elk feeding was at a high level during that time during some seasons.

Activity periods were shortest in fall when feeding was concentrated in the first and last hours of daylight and longest in late winter when most elk were observed between 1.5 and 2.5 hr after sunrise and before sunset.

Feeding was the predominant activity for elk observed within 3.5 hr after sunrise and

TABLE 15.—MEAN GROUP SIZE FOR ELK OBSERVED DURING SEASONS AND YEARS 1960–1964. NUMBERS OF ELK IN SAMPLES ARE IN PARENTHESES

Year	Summer	Fall	Winter	Spring	Year
1960–1961	4.0 (194)	7.5 (378)	7.9 (397)	6.1 (338)	6.4
1961–1962	3.7 (145)	6.7 (263)	14.6 (484)	7.5 (219)	7.9
1962–1963	4.2 (189)	12.6 (278)	10.8 (173)	4.7 (175)	6.8
1963–1964	5.9 (136)	6.4 (32)	8.2 (74)	4.6 (14)	6.4
1960–1964	4.3	8.1	10.4	6.0	6.9

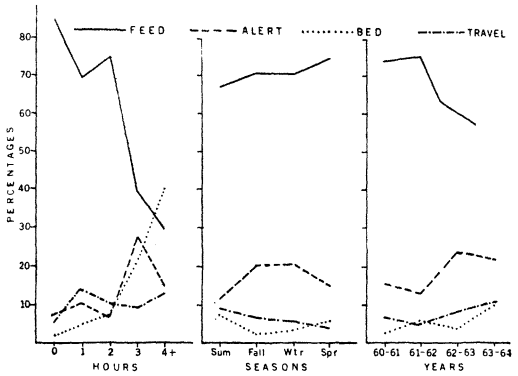

FIG. 25. Percentages of all elk observed in different activities during the normal activity periods after sunrise and before sunset, each season and each year.

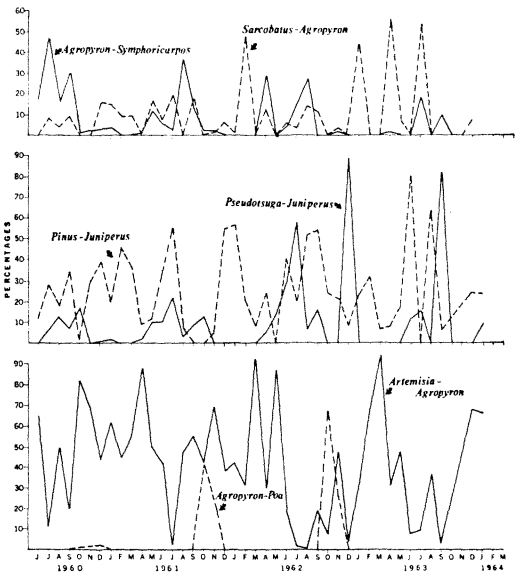

FIG. 26. Monthly frequencies of elk on habitat types receiving more than 10% of the total observed use during at least one month.

before sunset (Fig. 25). Higher percentages were observed feeding in spring than during other seasons. The indicated decrease in proportions feeding and increased percentages alert and traveling during 1962–1963 and 1963–1964, as compared to earlier years, were related to changes in range use and further, in 1963–1964, to undue influence of concentration of observations in summer.

Elk food and range-use habits, range forage conditions, and weather doubtless influenced elk activities, but these relationships were largely obscured by interactions.

Use of Habitat Types

The relative seasonal and yearly usage of the various habitat types by elk are presented in Table 16. Monthly trends in occurrence of elk on types receiving more than 10% of the total use for at least 1 month are shown in Figure 26. The variation in these data reflected both the small monthly samples in which single observations often influenced results, and actual trends in use of the different types.

Summer (June, July, August).—Use and importance of habitat types varied widely in summer. Use of the *Sarcobatus–Agropyron* type for all activities varied from minor to heavy during the 4 summers. As a feeding area, the type ranked first in overall summer usage for the 4 years and in 1962 and 1963, but ranked fifth in 1960 and 1961. It was used in association with the *Agropyron–Symphoricarpos* type, which received moderate to heavy use in all years, and the *Xanthium* type, which occasionally received heavy use when abundant growth of forbs occurred. These "coulee bottom" types collectively comprised the major feeding areas in summer, particularly in July and August.

The *Artemisia–Agropyron* type ranked second in average summer usage for total elk activities and for feeding, but use varied significantly between years in relation to the abundance of preferred food plants on other types. It was the most important type for feeding in 1960 and 1961 but its importance in 1962 and 1963 was minor or moderate. The *Artemisia–A. smithii* associes and the *Artemisia–A. spicatum* association were the most important communities, reflecting distributions on smaller ridges, benches, and along the edge of timbered types as well as development of the *Tragopogon* union.

Greatest summer usage occurred on timbered types. The *Pinus–Juniperus* and *Pseudotsuga–Juniperus* types were moder-

TABLE 16.—PERCENTAGES OF TOTAL ELK OBSERVED IN ALL ACTIVITIES (A) AND FEEDING ONLY (F) ON RANGELAND HABITAT TYPES IN THE MISSOURI RIVER BREAKS, MONTANA, 1960–1964. TRACE (T) AMOUNTS ARE LESS THAN 1%

Season Year	Number of Elk Observed	*Artemisia–Agropyron* A/F	*Agropyron–Poa* A/F	*Pinus–Juniperus* A/F	*Pseudotsuga–Juniperus* A/F	*Artemisia longifolia* A/F	*Sarcobatus–Agropyron* A/F	*Agropyron–Symphoricarpos* A/F	*Xanthium strumarium* A/F
Summer									
1960	194	31/30		22/18	8/0	1/1	6/12	13/14	19/25
1961	145	33/33		28/17	10/13		8/5	21/32	
1962	189	5/3		29/22	44/22	1/0	5/39	15/13	T/T
1963	136	15/14		27/0	12/10	2/4	33/56	11/17	
4-Year Total	664	21/20		27/17	19/12	1/T	12/25	15/18	6/7
Fall									
1960	378	58/65		26/18	5/4	T/T	2/4	6/6	3/2
1961	263	56/42	24/34	2/2	6/2		5/6	5/14	1/1
1962	278	40/10	29/51	25/32	1/0		4/5	1/2	
1963	32	3/0		6/25	81/50			9/0	
4-Year Total	951	50/46	15/22	18/13	7/4	T/T	4/5	5/9	1/1
Winter									
1961	379	49/50	T/0	36/34	T/T		13/13	1/T	T/1
1962	484	39/34		47/48			14/17		
1963	173	53/75		27/12	13/13		8/0		
1964	74	68/70		24/23	3/4		5/4		
4-Year Total	1,128	47/48	T/0	39/37	2/T		12/14	T/T	T/T
Spring									
1961	338	69/86		20/4	3/2		7/4	2/3	T/T
1962	219	73/75		11/11	4/3		4/6	8/5	T/1
1963	175	59/57		10/9	8/7	T/T	21/26	T/0	
1964	14			100/100					
4-Year Total	746	66/81		16/6	4/3	T/T	9/7	3/3	T/T
Yearlong									
1960-1961	1,307	54/64	T/0	27/20	3/2	T/T	7/8	5/4	4/3
1961-1962	1,111	49/42	6/12	27/22	4/3	T/0	9/10	6/10	T/T
1962-1963	815	39/28	10/14	23/20	15/10	T/T	9/23	4/5	T/T
1963-1964	256	28/33		28/12	17/11	1/2	19/31	7/11	
4-Year Total	3,489	47/52	4/5	26/20	7/3	T/T	9/12	5/6	2/2

ately important for feeding and more important than other types for bedding. The former typically was used most intensively during June, with the use occurring largely on the *Pinus–Agropyron* association. *Pseudotsuga–Juniperus* was especially important during and for a few weeks after calving. The increased occurrence of elk on the type during late July and early August seemed related to increased utilization of browse and to the persistence of forbs on the type.

Other habitat types were of little importance during the summer.

Fall (September, October, November).—The *Artemisia–Agropyron* type was the most heavily used habitat type during this period when grasses became increasingly important in the diet of elk. Use generally increased as the season progressed, but varied in relation to the availability of different grasses and the abundance of forbs on other types. The *Artemisia–A. smithii* associes was the most important community on the *Artemisia–Agropyron* type during 1960, whereas the *Artemisia–A. smithii* association appeared to be used more intensively during years of green-up.

The *Agropyron–Poa* type was heavily used in October and November of 1961 and 1962, following green-ups of Sandberg

bluegrass and junegrass on winter pastures in the south-central portion of the area. The more intensive use in 1962 reflected increased elk numbers on the area and possibly, greater availability of Sandberg bluegrass and junegrass after the pastures were cut for hay.

Overall use of the *Pinus–Juniperus* type was moderate. For feeding it was very minor in 1961 but prominent in 1962 and 1963 when forbs, especially yellow sweetclover, were abundant. The *Pinus–Agropyron* association was most important, but the *Pinus–Juniperus* association received intensive use in 1962. The *Pinus–Artemisia* association received only minor use, largely in September.

Relatively few elk were observed on other types during fall. Moderate feeding on the *Agropyron–Symphoricarpos* type in 1961 reflected utilization of green rabbitbrush and grass, primarily during September.

Data for the fall of 1963 were obtained only during September.

Winter (December, January, February).—The *Artemisia–Agropyron* type was most important 3 of the 4 winters and for all winters combined. The *Artemisia–A. smithii* associes was generally used most intensively. The *Artemisia–A. spicatum* association ranked second. It was especially important during 1961 when elk concentrated on areas in better range condition. Use on the *Artemisia–A. smithii* association varied in relation to availability of grasses as influenced by prior grazing and snow cover.

The *Pinus–Juniperus* type ranked second. The intensive use in the winter of 1961–1962 reflected attraction to the *Pinus–Agropyron* association on steeper, semiopen slopes where grasses persisted in relative abundance. Other communities received only occasional use.

Sarcobatus–Agropyron was the only other type of importance, receiving moderate use during all winters except 1963. This was largely on steeper slopes, in contrast to the predominant use on coulee bottoms during other seasons, where grasses were relatively abundant.

Spring (March, April, May).—The *Artemisia–Agropyron* type received the greatest use throughout the period. The most intensive use, occurring during late March and early April, coincided approximately with the onset of the spring green-up. The *Artemisia–A. smithii* association was the most important community, reflecting seasonal elk preferences for grasses and early developing forbs of the *Poa* union. The *Artemisia–A. smithii* associes received increasing use throughout spring. Relative use on the *Artemisia–Agropyron* type declined sharply during the last week of May as most adult females dispersed prior to calving.

Overall use of all other habitat types was minor or negligible, though use of some types was significant in some months, e.g., the *Sarcobatus–Agropyron* type in late March or early April and the *Pseudotsuga–Juniperus* type in late May by adult females.

Discussion.—Yearlong relations of elk to habitat types were characterized by significant trends. The coulee bottom types, *Sarcobatus–Agropyron*, *Agropyron–Symphoricarpos*, and *Xanthium* types, collectively comprised the most important area for feeding during summer and early fall but thereafter received only minor usage. Numbers of elk observed on the *Artemisia–Agropyron* type, which was most important overall, generally increased from very minor in midsummer through fall to late winter and early spring when feeding became concentrated there. The *Pinus–Juniperus* type received moderate use through summer and fall and was of major importance for feeding during winter when lightly or ungrazed stands of grass on semiopen, steeper slopes were important forage sources. It received only minor use during spring. Stands of *Pseudotsuga–Juniperus* received heavy use by female and calf elk during late May and early June and by all elk for bedding during summer and early fall. It was also relatively important for feeding in late summer. The *Agropyron–Poa* type was important only during October and November in years of fall green-up. Relatively few elk were recorded

TABLE 17.—PERCENTAGES OF TOTAL ELK OBSERVED ON SLOPES OF VARYING DEGREES OF STEEPNESS DURING SEASONS AND YEARS 1960–1964

Season	Sample Size	Degrees of Slope			
		0–10	11–25	26–35	35+
Summer	664	49.5	18.4	17.6	14.5
Fall	951	70.7	11.5	8.7	10.0
Winter	1,128	45.0	25.0	20.9	9.0
Spring	746	67.8	15.5	16.0	8.6
1960–1961	1,307	57.8	15.8	17.0	9.5
1961–1962	1,111	56.2	21.8	12.2	9.9
1962–1963	815	62.2	18.4	14.5	4.9
1963–1964	256	50.8	12.1	28.1	9.0
1960–1964	3,489	57.8	18.0	15.7	8.6

on the *Artemisia longifolia* type at all times.

Elk population and distributional phenomena on the study area precluded the use of observability indices as a measure of undetected use of timbered habitats. Although greater than observed use of both the *Pinus* and *Pseudotsuga* communities probably occurred in summer, especially late in the season, it seemed unlikely that the difference was sufficient to alter conclusions concerning the relative importance of the various types.

Elk were much more responsive than mule deer to changes in forage availability within and between seasons and years, readily moving from one habitat type to another as well as from one portion of the area to another as conditions demanded. The important differences between years were largely related to precipitation on the area and its influence on forage supplies and the feeding habits of elk.

Weather conditions generally did not appear to influence relative use of the various habitat types, except during winter when complete snow cover seemed to effect greater use on the *Pinus–Juniperus* type and decreased use of *Artemisia–Agropyron*.

Use of Slopes

The distribution of elk observations on slopes of varying steepness is presented in Table 17. Approximately 42% of all elk occurred on slopes steeper than 10°. Less than 1% were observed on slopes of 45° or more.

Use of slopes varied during seasons and years in relation to relative frequencies of use on the various habitat types. Seasonally greater use of steeper slopes largely

TABLE 18.—PERCENTAGES OF TOTAL ELK OBSERVED ON SLOPES OF VARIOUS EXPOSURE DURING SEASONS AND YEARS 1960–1964. PERCENTAGES ARE OF TOTAL OBSERVED ON SLOPES STEEPER THAN 10°

Season	Sample Size	% on 0–10° Slope	Exposure							
			N	NE	E	SE	S	SW	W	NW
Summer	664	49.5	26.0	19.1	3.3	4.4	14.6	12.4	5.0	11.3
Fall	951	70.7	16.9	20.9	0.7	3.2	24.5	21.2	4.7	6.7
Winter	1,128	45.0	22.1	21.1	7.9	4.0	7.9	13.1	12.9	10.7
Spring	746	67.8	19.2	12.4	14.5	26.9	16.2	4.3	4.7	1.7
1960–1961	1,307	57.8	13.8	19.7	5.6	10.2	24.6	14.2	4.8	7.1
1961–1962	1,111	56.2	32.2	16.1	7.2	8.9	2.5	7.4	15.1	10.5
1962–1963	815	62.2	19.6	25.2	3.7	4.7	11.0	17.6	5.3	11.3
1963–1964	256	50.8	19.5	14.8	12.8	0.0	19.5	18.1	2.7	2.0
1960–1964	3,489	57.8	21.6	19.2	6.5	7.6	14.0	13.1	8.1	8.6

TABLE 19.—PERCENTAGES OF TOTAL ELK OBSERVED AT ONE-FOURTH-MILE INTERVALS FROM KNOWN WATER SOURCES DURING SEASONS AND YEARS 1960–1964. TRACE (T) AMOUNTS ARE LESS THAN 1%

Season	Year	Sample Size	Distance Class in Miles								
			0–¼	¼–½	½–¾	¾–1	1–1¼	1¼–1½	1½–1¾	1¾–2	>2
Summer	1960	194	25.3	51.5	21.1	2.1					
	1961	145	20.0	46.2	15.2	6.9	3.4	3.4	4.8		
	1962	189	7.4	34.9	20.6	21.7	4.8	8.5	2.1		
	1963	136	13.2	50.7	32.4	2.9	T				
Total	1960–1963	664	16.6	45.5	22.0	8.9	2.1	3.3	1.7		
Fall	1960	378	15.6	15.1	38.4	16.9	9.8	4.2			
	1961	263	35.0	36.1	12.9	9.9	6.1				
	1962	278	15.5	40.3	38.1	2.9	3.2				
	1963	32		3.1	53.1	18.6			6.3		18.8
Total	1960–1963	951	20.4	27.9	31.8	10.9	6.5	1.7	T		T
Winter	1961	397		1.5	9.1	41.6	25.4	4.3	12.6	5.5	
	1962	484	19.0	19.2	38.6	10.7	2.3	4.3	4.1	1.7	
	1963	173	8.7	40.5	23.1	27.7					
	1964	74	58.1		14.9	24.3		2.7			
Total	1961–1964	1,128	13.3	15.0	24.3	25.1	9.9	3.5	6.2	2.7	
Spring	1961	338	1.5	4.7	11.2	32.0	39.6	6.5	4.4		
	1962	219	18.3	22.4	39.7	11.0		8.7			
	1963	175	21.7	29.7	28.6	10.9	6.3	2.9			
	1964	14			50.0				35.7	14.3	
Total	1961–1964	746	11.1	15.7	24.4	20.2	19.4	6.2	2.7	T	
Yearlong	1960–1961	1,307	8.6	13.7	19.9	26.1	20.8	4.2	5.0	1.7	
	1961–1962	1,111	22.8	27.4	29.7	10.1	2.9	4.1	2.4	T	
	1962–1963	815	13.5	36.8	28.8	14.2	3.6	2.6	T		
	1963–1964	256	23.8	27.3	30.9	10.9		1.2	2.7	T	2.3
Total	1960–1964	3,489	15.4	24.4	25.9	17.1	9.5	3.6	3.0	T	T

reflected use on the *Pinus–Juniperus* and *Pseudotsuga–Juniperus* types in summer and the *Pinus–Juniperus* and *Sarcobatus–Agropyron* types in winter. The high percentages observed on level to gently sloping sites in fall and spring corresponded to intensive use on the *Artemisia–Agropyron* type.

Use of Exposures

The distribution of elk observed on slopes of various exposures during seasons and years is presented in Table 18. Although the results partly reflect relative amounts of area with each exposure, northerly exposures appeared to receive especially intensive use in summer when most elk ranged in proximity to the *Pseudotsuga–Juniperus* type. Greater use of west and northerly exposures was evident during winter when upper portions of slopes dominated by *Pinus–Agropyron* were important feeding areas. Cold winds and snow depths which prevailed in winter did not appear to influence use of northerly exposures by elk. Exceptionally intense use appeared on south-, southeast-, and east-facing slopes in spring.

Relations to Water

Relative percentages of elk observed at various distances from water are presented in Table 19. Most observations during summer and fall were within 0.75 mile of a water source, though greatest numbers typically occurred between 0.25 and 0.75 mile. Use at distances of a mile or more was minor at all times, and considerably lower than recorded for mule deer.

Year-to-year relationships reflected the distribution of water in relation to areas used by elk in the same manner as described for mule deer. The percentages of elk observations within 0.5 mile of water decreased

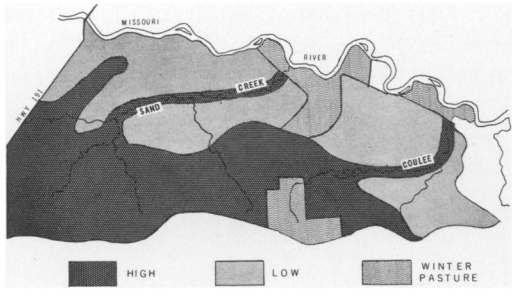

FIG. 27. Generalized distribution of cattle densities for the April–November grazing seasons, and locations of livestock winter pastures on the Missouri River Breaks study area, 1960–1964.

and the number at greater distances increased in the summer of 1961, as compared to 1960, when water sources were at a minimum. Use at greater distances was also higher in 1962 and 1963 when elk used timbered and coulee bottom habitats more intensively than in prior years when intensive use occurred on the *Artemisia–Agropyron* type in proximity of reservoirs.

Use on areas more distant from permanent water sources was greatest during winter and early spring when elk were distributed on the southeastern portion of the study area where few reservoirs existed. Yearly differences were related to the degree and location of elk concentration.

Cattle

Range-use characteristics of cattle were evaluated in the same manner as those of mule deer and elk. The total of 233 observational trips typically included one morning and one afternoon each week during the grazing season, except during July and August 1960 and after September 1963. A total of 25,107 cattle observations, used in evaluating range-use habits, was recorded as follows: 1960–1961, 6,562; 1961–1962, 7,466; 1962–1963, 6,291; and 1963–1964, 4,788.

Distribution

The entire area, except portions of some Missouri River bottomlands, was subject to use by cattle. During the 1 April–30 November grazing season, greatest cattle numbers occurred on the southern half of the study area; light or occasional use prevailed on the northern and extreme eastern portions (Fig. 27). The only important exception occurred during 1962 when the area of greatest cattle density extended farther north along the Wilder Trail, and light use prevailed over most of the southwestern portion. Use of local areas varied considerably during all years, reflecting changes in forage availability, water supplies, and weather conditions.

The areas of greatest cattle densities were major coulee bottoms and uplands of the *Artemisia–Agropyron* and *Agropyron–Poa* habitat types associated with ridgetops, slight to moderate slopes, and well-distributed water sources. Areas of light or occasional use were those with inadequate water or broken topography with steep slopes and limited ridgetop area. Access to the extreme eastern portion of the area was also limited by fences. It appeared that grazing pressures were substantially greater where cattle could disperse from water over extensive areas of primary range types. Use of distal portions of ridges where the dispersal area was limited was generally low even with sufficient water.

Cattle were observed on areas of light use most frequently during fall, following heavy utilization of forage on preferred sites,

TABLE 20.—MEAN GROUP SIZES FOR CATTLE OBSERVED DURING SEASONS AND YEARS 1960–1964. NUMBERS OF CATTLE IN SAMPLES ARE IN PARENTHESES

Year	Summer	Fall	Winter	Spring	Year
1960–1961	7.5 (548)	5.7 (2,879)	8.3 (411)	7.4 (2,724)	6.6
1961–1962	4.9 (3,519)	4.5 (2,358)	6.1 (154)	7.4 (1,435)	5.1
1962–1963	7.1 (3,379)	5.2 (1,298)	4.7 (71)	11.2 (1,543)	7.2
1963–1964	13.6 (3,254)	8.5 (1,388)	11.7 (82)	64.0 (64)	11.6
1960–1964	7.1	5.5	7.4	8.2	6.7

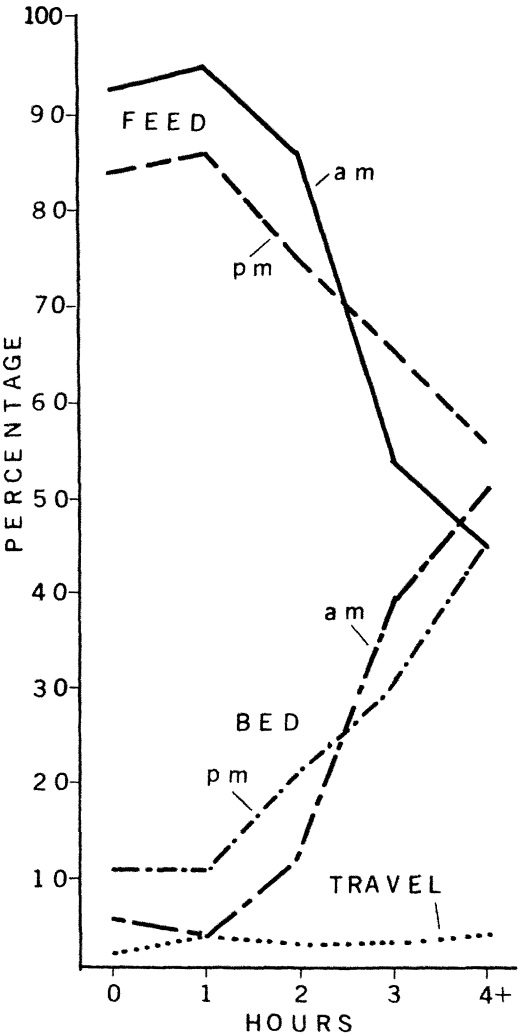

FIG. 28. Percentages of all cattle observed in different activities each hour after sunrise (AM) and before sunset (PM).

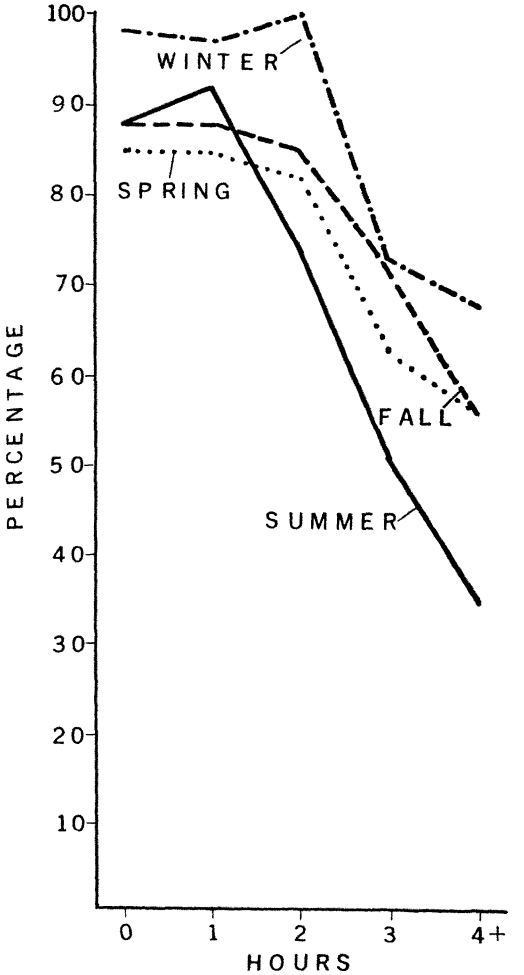

FIG. 29. Percentages of all cattle observed feeding each hour after sunrise and before sunset at different seasons. Data are combined for morning and evening activity periods.

when rains provided additional water sources and cooler temperatures enabled more extensive movement. Some use also occurred during spring, especially in the drought years, when impounded runoff water was available and forage was relatively more abundant. These areas were most heavily used during 1961 when reduced production and heavy use of forage on more intensively grazed sites forced cattle to range more widely.

Most cattle were turned onto winter pastures and removed from the area by the end of the grazing season. Winter pastures on the south-central portion of the area were not grazed by cattle during the winter of 1961–1962. The upland portion of the north-central winter pasture usually was grazed only during the early winter period.

Group Characteristics

Average numbers of cattle observed per group (Table 20) varied in relation to the

degree of dispersal and use of certain habitat types as well as the type and duration of activity. Group sizes usually were smallest during drought years, especially 1961–1962, when cattle were relatively dispersed, sought forage on normally less used areas and timbered habitat types, and fed more intensively during much of the day. Larger groups prevailed during the last 2 years when cattle were relatively concentrated during most periods with abundant forage in proximity to water sources, heavier seasonal use on ridgetops, and less intensive feeding.

Activity Habits

Activities of cattle resembled those of mule deer and elk in that feeding was most intensive during 3–4-hr periods in early morning and late afternoon, but most cattle also fed sporadically between these periods. For the 4-year period, greatest numbers were observed during the first and last hours of daylight. Approximately 67% of all cattle and 76% of feeding cattle observed during observation periods were recorded within 2.5 hr after sunrise and before sunset, with 84 and 89%, respectively, observed within 3.5 hr. These percentages were high for total daily activities because observations usually were not continuous through midday during late spring, summer, and early fall.

Percentages of the total number of cattle observed feeding during morning, evening, seasonal, and yearly periods are shown in Figures 28, 29, and 30. Periods of intensive activity were shortest during summer and longest in winter. The duration of intensive activity as well as the extent of feeding later in the day varied in relation to range forage conditions. Intensive activity was most prolonged during drought years, 1960–1961 and 1961–1962, when cattle were relatively active throughout the day as compared with 1962–1963 and 1963–1964 when decreased proportions observed feeding more than 2.5 hr after sunrise and before sunset reflected improved forage conditions.

Feeding predominated the recorded activity for cattle within 3.5 hr after sunrise and before sunset. Feeding was more intensive in early morning than late evening. Proportions observed bedded increased sharply between 2.5 hr after sunrise and 1.5 hr before sunset. Traveling was a minor activity at all times. Proportions traveling were highest between 2.5 and 3.5 hr after sunrise and between 0.5 hr before and after sunset when greatest numbers of cattle moved toward reservoirs and evening feeding areas, respectively. Greater numbers were observed traveling during 1961–1962 when extensive movement occurred between feeding and bedding (reservoir) areas.

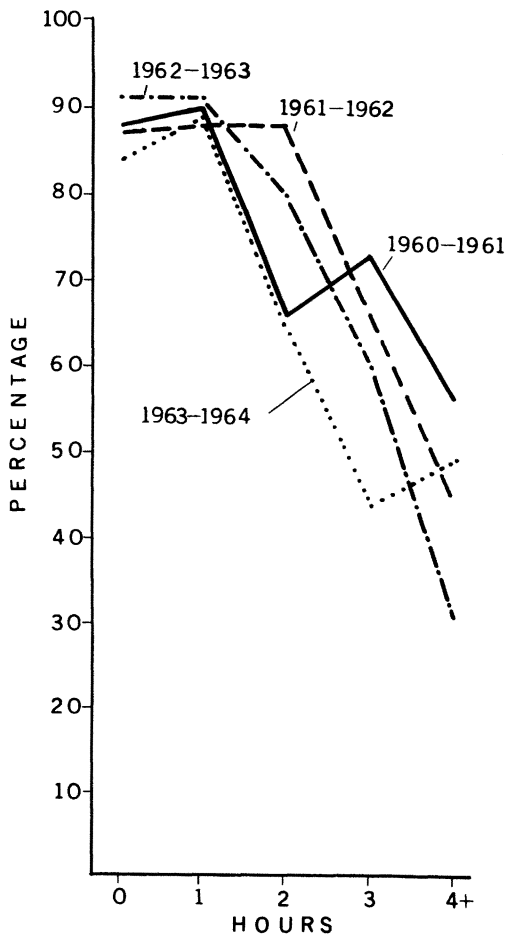

FIG. 30. Percentages of all cattle observed feeding each hour after sunrise and before sunset each year. Data are combined for morning and evening activity periods.

TABLE 21.—PERCENTAGES OF TOTAL CATTLE OBSERVED IN ALL ACTIVITIES (A) AND FEEDING ONLY (F) ON RANGELAND HABITAT TYPES IN THE MISSOURI RIVER BREAKS, MONTANA, 1960–1964. TRACE (T) AMOUNTS ARE LESS THAN 1%

Season Year	Number of Cattle Observed	*Artemisia–Agropyron* A/F	*Agropyron–Poa* A/F	*Pinus–Juniperus* A/F	*Pseudotsuga–Juniperus* A/F	*Artemisia longifolia* A/F	*Sarcobatus–Agropyron* A/F	*Agropyron–Symphoricarpos* A/F	*Xanthium strumarium* A/F
Summer									
1960	548	39/37	10/11	26/28	T/T		16/16	6/4	T/T
1961	3,519	60/61	4/4	18/13	T/T	T/T	9/12	7/8	T/1
1962	3,379	58/58	9/9	15/17	T/T	T/T	11/9	5/6	T/T
1963	3,254	63/66	4/4	17/15	2/2		11/9	4/4	T/T
4-Year Total	10,700	60/59	6/6	17/16	1/T	T/T	11/11	5/6	T/T
Fall									
1960	2,879	55/56	1/2	12/11	T/T	T/T	26/26	6/6	T/T
1961	2,358	65/66	4/3	17/18	T/T	T/T	7/7	6/6	T/T
1962	1,298	67/67	3/3	17/16	T/T		10/10	3/3	T/T
1963	1,388	70/72	2/2	11/9	4/5		8/6	5/5	T/T
4-Year Total	7,923	63/64	2/2	14/14	1/T	T/T	14/14	5/5	T/T
Winter									
1961	411	53/62	35/27	5/3			6/8	T/T	
1962	154	67/83		27/14			6/5		
1963	71	82/88		18/12					
1964	82	13/13	83/83	1/1			2/2		
4-Year Total	718	55/66	29/22	11/7			5/5	T/T	
Spring									
1961	2,724	77/80	7/7	12/8	T/T		2/2	2/2	T/T
1962	1,435	55/55	6/3	12/15	T/0		20/21	6/6	T/T
1963	1,543	57/64	8/8	8/6	T/T	T/T	21/15	5/6	T/1
1964	64	100/100							
4-Year Total	5,766	67/70	7/6	11/9	T/T	T/T	11/10	4/3	T/T
Yearlong									
1960-1961	6,562	63/65	7/6	12/11	T/T	T/T	14/14	4/4	T/T
1961-1962	7,466	61/63	4/3	17/15	T/T	T/T	11/11	6/7	T/T
1962-1963	6,291	60/62	8/7	14/14	T/T	T/T	13/10	5/5	T/T
1963-1964	4,788	65/67	4/5	14/12	2/2		10/8	4/5	T/T
4-Year Total	25,107	62/64	6/5	14/13	T/T	T/T	12/11	5/5	T/T

Use of Habitat Types

Relative intensities of cattle use on the different habitat types during seasonal and yearly periods are presented in Table 21. Monthly trends on types which received more than 10% of the total use during months are illustrated in Figure 31.

Summer (June, July, August).—The *Artemisia–Agropyron* type was most important in summer for all years. Relative intensities of use generally decreased through the period, being lowest in August. Use was predominantly on the *Artemisia–A. smithii* association. Use of the *Artemisia–A. smithii* associes varied in relation to the distribution of water on the area. It was used more intensively during 1961 when cattle ranged farther to obtain forage. The *Artemisia–A. spicatum* association received only very light use.

The *Pinus–Juniperus* type ranked second, receiving moderate use for feeding and some additional use for bedding and loafing. It typically was used most intensively during mid- and late summer. The *Pinus–Agropyron spicatum* association on slopes of less than about 25° was the most important community with the *Pinus–Juniperus* association receiving some use for both

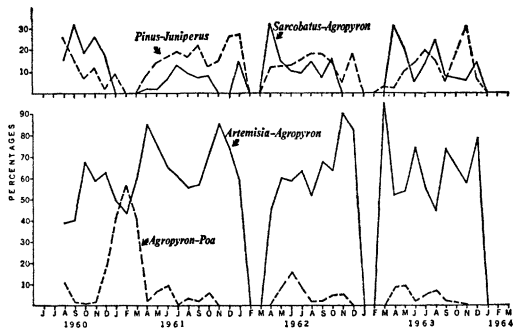

FIG. 31. Monthly frequencies of cattle on habitat types receiving more than 10% of the total observed use during at least one month.

feeding and bedding. The *Pinus–Artemisia* association was only rarely used by cattle.

The *Sarcobatus–Agropyron* type ranked third for feeding during 3 of the 4 summers and for all years combined. Overall, it was of moderate importance, but use reached significant proportions during August of some years.

Use on the *Agropyron–Symphoricarpos* and *Agropyron–Poa* types was minor during all years. The former received its greatest use during August when green forage persisted.

Other habitat types received very minor use at all times.

Fall (September, October, November).—The *Artemisia–Agropyron* type was by far the most important habitat for feeding as well as all activities during fall. The *Artemisia–A. smithii* association remained the most important community, but use on the *Artemisia–A. smithii* associes increased as precipitation provided additional water sources and cattle movement became more extensive with cooler temperatures. The *Artemisia–A. spicatum* association received only very minor use.

The *Pinus–Juniperus* type was moderately important, ranking second in 3 of the 4 years. Usage on individual communities was similar to summer though slightly increased use on the *Pinus–Juniperus* association occurred late in the period.

Overall use on the *Sarcobatus–Agropyron* type was about equal to that on the *Pinus–Juniperus* type, largely because of relatively intense use during 1960. The type ranked third and was of minor importance during other years.

The *Agropyron–Symphoricarpos* and *Agropyron–Poa* types received minor and very minor use respectively in all years.

Use of other types was negligible.

Winter (December, January, February).—Cattle use of upland habitats during this period was largely confined to winter pastures on the north- and south-central portions of the area. Winter use on the former area was predominantly on the *Artemisia–Agropyron* type. Use varied through the winter on the south-central area, but both the *Artemisia–Agropyron* type and the *Agropyron–Poa* type were important.

The *Pinus–Juniperus* type was of minor importance, but use occasionally reached significant proportions on the north-central pasture in early winter. This use was almost entirely on the *Pinus–Agropyron* association.

The *Sarcobatus–Agropyron* type also received minor use, primarily in December and January.

Use on other habitat types was negligible during winter.

Spring (March, April, May).—Cattle use during March was entirely on winter pastures on the south-central portion of the area. Less than 1% of the total recorded observations in spring occurred during that month.

The *Artemisia–Agropyron* type received the most intensive use during April and May. The *Artemisia–A. smithii* association was the most important community, especially during April. The *Artemisia–A. smithii* association received heavy use during some years, particularly during May.

Relatively few cattle were observed on other habitat types during spring. The *Sarcobatus–Agropyron* type was of only minor importance overall, but received some significant use during April 1962 and 1963. *Pinus–Juniperus* was also of minor impor-

tance, though moderate use was observed during April and May 1962. The prominence of both the *Sarcobatus* and *Pinus* communities in the spring of 1962 reflected the relatively low number of cattle on the study area and the somewhat better forage conditions on these types during April. Other types were used only occasionally and were of very minor importance.

Discussion.—Relations of cattle to habitat types were significant in that a single type, *Artemisia–Agropyron*, was used most intensively and relatively few other types received heavy usage. Some monthly and seasonal differences reflected the availability of water and the abundance of forage as influenced by prior grazing. Yearly differences were related largely to precipitation and its influence on plant growth and water supplies. The *Sarcobatus–Agropyron* and *Agropyron–Symphoricarpos* types, which received moderate and minor use, respectively, collectively comprised the second most important area for feeding. Use on those types was most intensive during early spring and late summer. The *Pinus–Juniperus* type was of moderate importance overall. Relative intensities of use generally increased from spring through early fall, then decreased to the end of the grazing season. The *Agropyron–Poa* type received very minor use throughout the period. Only occasional or transient use occurred on other habitat types.

Relative intensities of cattle use on the various habitat types on winter pastures were similar to that during the grazing season, except on the south-central portion of the area where the *Agropyron–Poa* type received important use during some winters.

Weather conditions did not appear to influence relative use of the different types for feeding, except that as temperatures increased movement decreased, influencing greater cattle use on pine communities close to water.

Use of Slopes

Percentages of total cattle observed during seasons and years on slopes of varying steepness are presented in Table 22. Use was predominantly on level to gently sloping sites and decreased sharply on steeper slopes during all periods. Slopes steeper than 25° received only very minor use by cattle. This plus the increased use on steeper slopes in winter, when cattle were confined to pastures, and during 1961–1962, when forage supplies on normally grazed sites were minimal, suggested that steepness of slope exerted important influence on the distribution of cattle use on the area.

TABLE 22.—PERCENTAGES OF TOTAL CATTLE OBSERVED ON SLOPES OF VARYING DEGREES OF STEEPNESS DURING SEASONS AND YEARS 1960–1964. TRACE (T) AMOUNTS ARE LESS THAN 1%

Season	Sample Size	Degree of Slope			
		0–10	11–25	26–35	35+
Summer	10,700	82.2	13.2	4.2	T
Fall	7,923	82.0	12.7	4.3	1.0
Winter	718	80.4	9.4	10.1	T
Spring	5,766	81.4	14.6	3.6	T
1960–1961	6,562	83.1	11.7	4.6	T
1961–1962	7,466	75.5	17.8	5.8	1.0
1962–1963	6,291	83.3	12.9	3.5	T
1963–1964	4,788	88.5	8.9	2.3	T
1960–1964	25,107	81.9	13.3	4.2	T

Use of Exposures

The distribution of observed cattle use on slopes by direction of exposure (Table 23) appeared largely related to relative amounts of area with each exposure. Overall use was only slightly greater on northerly than on southerly exposures. Increased use on upper portions of north-facing slopes, where grasses typically were abundant, occurred in fall and during 1961–1962.

Relations to Water

Relative percentages of cattle observed during seasons and years at various distances from known water sources are presented in Table 24. Most observations occurred within 0.75 mile of a water source. Greatest numbers typically were observed within 0.25 mile of water, and only minor use was recorded at distances greater than

TABLE 23.—PERCENTAGES OF TOTAL CATTLE OBSERVED ON SLOPES OF VARIOUS EXPOSURE DURING SEASONS AND YEARS 1960–1964. PERCENTAGES ARE OF TOTAL OBSERVED ON SLOPES STEEPER THAN 10°

Season	Sample Size	% on 0–10° Slope	Exposure							
			N	NE	E	SE	S	SW	W	NW
Summer	10,700	82.2	19.9	17.0	5.9	6.8	22.3	14.4	7.1	5.7
Fall	7,923	82.0	29.7	11.4	5.9	5.0	19.9	14.0	4.5	9.5
Winter	718	80.4	13.1	19.0	8.0	12.4	21.2	16.1	0.0	10.2
Spring	5,766	81.4	13.8	23.9	9.1	10.3	15.0	15.0	2.7	10.3
1960–1961	6,562	83.1	17.2	19.2	7.6	6.6	18.0	15.7	3.5	12.1
1961–1962	7,466	75.5	26.0	13.8	5.5	10.3	19.8	11.3	5.8	6.5
1962–1963	6,291	83.3	19.1	19.9	8.4	4.9	16.1	19.1	5.1	7.4
1963–1964	4,788	88.5	19.2	16.3	5.7	1.8	30.3	14.0	5.5	6.5
1960–1964	25,107	81.9	21.4	16.8	6.7	7.2	19.8	14.4	5.0	8.1

a mile. During summer, when permanent water sources were most important, use was predominantly on sites less than 0.5 mile from water. More than two-thirds of all observations were within that distance during 1961 when the number of water sources was minimal. This was in contrast to observations for mule deer and elk suggesting that the distribution of cattle use on the area was more closely related to the distribution of water. Cattle use at greater distances from water increased during fall as water supplies and cattle movement increased.

The concentration of cattle use near water sources in spring reflected increased availability of water as well as the predominant use on more intensively grazed sites early in the period. In 1962, when most cattle were turned onto the area during May, distributions with respect to water were similar to summer.

FOOD HABITS

Mule Deer

A total of 40,982 instances of plant use was recorded at 263 mule deer feeding sites on the different habitat types between June 1960 and March 1964. The number of instances at each site ranged from 50 to 500, but typically was between 100 and 200 (average 156). Smaller samples were characteristic of minor habitat types and early summer when sizes of mule deer groups were small.

Data on plant taxa which received at least 10% of the total seasonal instances of use on at least one habitat type or 1% of the total for all types combined over the 4 years are presented in Table 25. Relative seasonal and yearly intensities of use of forage classes and several individually important forage plants are shown in Tables 26 and 27, respectively.

Summer

Eighty-seven mule deer feeding sites were examined during the 4 summers: 27, 27, 23, and 10 for 1960, 1961, 1962, and 1963, respectively. Feeding was recorded on 62 taxa, including 44 forbs, 12 shrubs, and 6 grasses or sedges. Nine of those plants, 5 forbs and 4 shrubs, each received an average of more than 1% of the total instances of use during summers.

Forbs comprised slightly more than half the recorded instances of use overall and during 3 of the 4 summers. The class predominated on all but the timbered habitat types. Yellow sweetclover was by far the most important taxon, being heavily utilized wherever it occurred after flowering commenced in early June. It was present on 87% and was eaten on 70% of all mule deer feeding sites and accounted for 44.5% of the total combined summer use. Other forbs individually received relatively minor usage. The more important were bastard toadflax and common salsify, which occurred commonly and were utilized throughout the

TABLE 24.—PERCENTAGES OF TOTAL CATTLE OBSERVED AT ONE-FOURTH-MILE INTERVALS FROM KNOWN WATER SOURCES DURING SEASONS AND YEARS 1960–1964. DATA FOR SUMMER OF 1960 ARE FOR AUGUST ONLY. TRACE (T) AMOUNTS ARE LESS THAN 1%

Season	Year	Sample Size	Distance Class in Miles								
			0–¼	¼–½	½–¾	¾–1	1–1¼	1¼–1½	1½–1¾	1¾–2	>2
Summer	1960	548	26.6	17.2	18.4	25.7	9.1	1.6	1.3		
	1961	3,519	46.2	24.3	13.2	8.1	3.6	1.4	2.3	T	
	1962	3,379	31.8	22.1	22.8	15.1	4.9	2.3	T		T
	1963	3,254	37.8	25.8	26.6	8.8	1.0				
Total	1960–1963	10,700	38.1	23.7	20.6	11.4	3.5	1.3	1.0	T	T
Fall	1960	2,879	29.8	9.0	19.6	12.7	15.4	6.5	6.3	T	T
	1961	2,358	35.4	26.9	15.1	10.0	4.4	4.1	3.6	T	
	1962	1,298	19.3	14.6	33.4	14.3	10.0	2.0	2.9	3.5	
	1963	1,388	39.8	7.5	30.5	8.1	9.1	3.2		T	1.2
Total	1960–1963	7,923	31.5	15.0	22.4	11.4	10.1	4.5	3.8	1.1	T
Winter	1961	411	59.9	20.7	13.1	3.6	1.7		1.0		
	1962	154	56.5			38.3	3.9	1.3			
	1963	71	42.3	42.3	2.6	9.0	3.8				
	1964	82	86.6		1.2	8.5		2.4			1.2
Total	1961–1964	718	60.3	16.3	7.9	12.1	2.2	T	T		T
Spring	1961	2,724	38.8	37.8	11.1	6.4	3.3	T	1.7		
	1962	1,435	34.6	17.4	24.7	19.8	2.0	1.6			
	1963	1,543	47.2	29.4	13.5	8.1	1.2	T			
	1964	64	100.0								
Total	1961–1964	5,766	40.7	30.1	15.0	10.1	2.4	T	T		
Yearlong	1960–1961	6,562	35.2	22.4	15.6	10.6	9.0	3.3	3.6	T	T
	1961–1962	7,466	40.8	23.3	15.7	11.6	3.6	2.3	2.2	T	
	1962–1963	6,291	47.2	29.4	13.5	8.1	1.2	T			
	1963–1964	4,788	40.1	19.7	26.9	8.5	3.3	1.0		T	T
Total	1960–1964	25,107	37.3	22.2	19.5	11.1	5.3	2.2	1.8	T	T

area, and wild licorice which was abundant and grazed only on the minor *Agropyron–Symphoricarpos* and *Xanthium* habitat types.

Browse ranked second for deer in total use on feeding sites and was the primary forage on the important *Pinus–Juniperus* and *Pseudotsuga–Juniperus* types. Early summer usage was largely of leaves; browsing of twigs increased progressively and predominated by late summer. Skunkbrush sumac ranked second among all taxa in the total seasonal use and was the most important taxon on the timbered habitats. Considering the observed and inferred importance of the timbered habitats, it may have been the single most important plant overall. Snowberry, rose (*Rosa arkansana* Porter and *R. nutkana* Presl.), and chokecherry ranked third, fourth, and fifth, respectively, among all taxa for all types combined. Chokecherry was taken largely on the *Pseudotsuga–Juniperus* type where it was the second most important taxon for feeding. Snowberry and rose received prominent usage on both timbered types. Western snowberry on the *Agropyron–Symphoricarpos* type was the only shrub to receive significant feeding use on a nontimbered habitat during summer.

Utilization of grass and grass-like plants was negligible at all times during summer. Most of that which occurred was incidental to feeding on other plants.

Fall

Data were obtained at 49 mule deer feeding sites: 22, 18, 4, and 5 for 1960, 1961, 1962, and 1963, respectively. Fifty-three taxa, 33 forbs, 12 shrubs, and 8 grasses,

TABLE 25.—SEASONAL FREQUENCIES AND AGGREGATE MEAN PERCENTAGES OF USE OF PLANT TAXA BY MULE DEER AT FEEDING SITES ON RANGELAND HABITAT TYPES IN THE MISSOURI RIVER BREAKS, MONTANA (SEE TEXT). TRACE (T) AMOUNTS ARE LESS THAN 1%. NUMBERS IN PARENTHESES ARE THE NUMBER OF FEEDING SITES EXAMINED AND THE TOTAL NUMBER OF TAXA USED ON THE TYPE DURING THE SEASON, RESPECTIVELY

Habitat Type	Summer		Fall		Winter		Spring	
Plant Taxa	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use
Artemisia–Agropyron Type	(18-14)		(11-15)		(27-27)		(27-38)	
Poa secunda	6	T	27	17	15	1	59	12
Grass Total	6	T	36	18	37	2	85	16
Comandra umbellatum	33	6	27	T			30	10
Lomatium foeniculaceum							52	10
Melilotus officinalis	94	85	54	36	15	T	22	3
Forb Total	94	94	73	45	44	10	89	49
Artemisia tridentata			27	10	85	56	70	32
Chrysothamnus nauseosus	11	T	54	26	41	22	4	T
Browse Total	17	6	73	37	96	88	79	35
Agropyron–Symphoricarpos Type	(5-9)		(6-7)		(1-2)		(2-9)	
Grass Total	40	1					50	1
Glycyrrhiza lepidota	80	3	33	16			50	1
Melilotus officinalis	80	56	33	2				
Forb Total	100	62	50	19			50	4
Artemisia cana			33	4	100	26		
Chrysothamnus viscidiflorus			33	30	100	74	100	48
Symphoricarpos spp.	60	36	50	46			50	41
Browse Total	60	37	83	81	100	100	100	95
Agropyron–Poa Type	(1-1)		(1-4)				(1-7)	
Poa secunda							100	79
Grass Total			100	1			100	83
Fritillaria pudica							100	12
Melilotus officinalis	100	100						
Tragopogon dubius			100	17				
Forb Total	100	100	100	18			100	17
Chrysothamnus nauseous			100	81				
Browse Total			100	81				
Pinus–Juniperus Type	(38-42)		(17-37)		(20-25)		(22-45)	
Grass Total	13	T	28	2	20	T	50	7
Melilotus officinalis	58	24	22	2	20	7	9	2
Forb Total	79	36	67	15	55	14	68	27
Artemisia cana			6	5	15	10	23	3
Artemisia longifolia	3	T	22	11	25	6	14	T
Artemisia tridentata			11	7	40	8	50	13
Chrysothamnus viscidiflorus			22	20	35	5	9	1
Juniperus scopulorum			33	7	80	18	50	20
Rhus trilobata	84	44	83	33	85	14	50	10
Symphoricarpos spp.	60	10	56	11	70	18	41	6
Browse Total	92	64	100	83	100	86	100	66
Pseudotsuga–Juniperus Type	(10-24)		(6-14)		(6-17)		(4-23)	
Grass Total	20	T	20	T	17	T	25	T
Melilotus officinalis	50	11	40	8	17	1	25	10
Forb Total	70	17	40	14	33	2	75	19
Artemisia tridentata					68	15	25	T
Chrysothamnus viscidiflorus	10	T	20	18	68	29	25	T
Juniperus scopulorum	10	T	40	1	100	30	50	23
Prunus virginiana	80	14	40	5	68	4		
Pseudotsuga menziesii					17	7	50	24
Rhus trilobata	90	44	80	21	100	4	50	7
Rosa spp.	80	6	40	4	50	T	75	10
Symphoricarpos spp.	80	11	100	32	68	5	50	11
Browse Total	100	82	100	86	100	98	100	81
Sarcobatus–Agropyron Type	(6-11)		(4-17)		(8-18)		(9-21)	
Poa secunda			25	19	12	10	56	16
Grass Total			25	19	50	12	56	19
Melilotus officinalis	83	71	50	26	25	5		

TABLE 25.—*Continued*

Habitat Type	Summer		Fall		Winter		Spring	
Plant Taxa	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use
Musineon divaricatum							56	11
Sphaeralcea coccinea			25	19				
Tragopogon dubius	50	17	50	T	12	T	22	T
Forb Total	100	98	100	56	50	8	89	28
Artemisia tridentata					50	30	89	47
Chrysothamnus viscidiflorus			25	25	12	12	11	T
Sarcobatus vermiculatus			25	T	75	25	44	T
Browse Total	50	2	50	25	100	80	89	53
Xanthium Type	(6-9)		(1-3)					
Glycyrrhiza lepidota	68	3	100	19				
Melilotus officinalis	50	24	100	74				
Forb Total	100	71	100	93				
Symphoricarpos spp.	50	24						
Browse Total	50	29	100	7				
Artemisia longifolia Type	(3-10)		(3-8)					
Glycyrrhiza lepidota	68	24						
Melilotus officinalis	68	50	33	T				
Forb Total	100	87	100	7				
Artemisia longifolia			100	89				
Rosa spp.	33	10	33	2				
Browse Total	67	13	100	93				
All Types Combined	(87-62)		(49-53)		(62-39)		(65-67)	
Agropyron smithii	3	T	8	T	13	T	40	2
Poa secunda	1	T	10	6	11	2	42	10
Grass Total	12	T	24	6	31	2	65	13
Allium textile							46	6
Artemisia frigida			2	T	13	2		
Artemisia ludoviciana			2	1	2	T		
Aster commutatus	8	T	29	3	3	T	5	T
Comandra umbellatum	13	1	8	T			20	4
Fritillaria pudica							15	3
Glycyrrhiza lepidota	15	1	6	2			2	T
Lomatium foeniculaceum							34	5
Melilotus officinalis	70	45	37	14	18	3	14	2
Microseris nutans	1	T	2	T			42	4
Musineon divaricatum	1	T					17	2
Phlox hoodii			2	T	13	2	15	3
Sphaeralcea coccinea	1	T	8	2			3	T
Tragopogon dubius	28	2	24	1	21	1	35	1
Yucca glauca	2	1			2	T	2	T
Forb Total	86	56	69	26	47	10	80	35
Artemisia cana			6	2	10	4	9	1
Artemisia longifolia	1	T	16	10	11	3	6	T
Artemisia tridentata			10	5	63	33	60	24
Atriplex nuttallii	1	T			5	1	2	T
Chrysothamnus nauseosus	5	T	20	9	21	11	8	1
Chrysothamnus viscidiflorus	2	T	20	15	24	8	9	2
Juniperus scopulorum			16	3	47	10	23	9
Prunus virginiana	16	2	8	T	10	T	6	T
Pseudotsuga menziesii					2	T	3	2
Rhus trilobata	48	25	43	15	44	5	25	4
Rosa spp.	45	5	24	2	19	T	22	2
Sarcobatus vermiculatus			2	T	14	4	8	T
Symphoricarpos spp.	45	9	39	13	34	7	18	4
Browse Total	68	43	88	74	98	87	88	52

were utilized. Fifteen of these, 5 forbs, 9 shrubs, and 1 grass, each received more than 1% of the total combined fall use.

Use of forbs decreased from summer, though yellow sweetclover continued to be eaten intensively and was one of the more important forage sources during September. Subsequent utilization of sweetclover was generally minor but varied in relation to late summer–early fall growth and persistence of first-year stems and the abundance of dry seed stalks. Use of other forbs was

TABLE 26.—PERCENTAGES OF GRASS, BROWSE, AND FORBS UTILIZED BY MULE DEER ON FEEDING SITES ON HABITAT TYPES WHICH RECEIVED AT LEAST 10% OF THE TOTAL MULE DEER USE DURING ONE SEASON, BY SEASON AND YEAR 1960–1964. TRACE (T) AMOUNTS ARE LESS THAN 1%

Forage Class	*Artemisia–Agropyron*				*Pinus–Juniperus*				*Pseudotsuga–Juniperus*				*Sarcobatus–Agropyron*				All Types Combined			
	Sum	Fall	Wtr	Spr	Sum	Fall	Wtr	Spr	Sum	Fall	Wtr	Spr	Sum	Fall	Wtr	Spr	Sum	Fall	Wtr	Spr
Grass and Grass-like																				
1960–1961	0	0	T	9	T	0	0	2	0	0	0	1	—	—	T	7	T	0	T	6
1961–1962	T	65	5	16	T	5	3	2	0	—	0	0	0	25	T	18	T	17	3	14
1962–1963	0	2	3	39	T	T	T	30	0	2	—	0	0	0	45	87	T	1	12	36
1963–1964	0	0	1	—	T	T	0	—	T	0	T	—	0	—	—	—	T	T	T	—
1960–1964	T	18	2	16	T	2	T	7	T	T	T	T	0	19	12	19	T	5	2	13
Browse																				
1960–1961	0	57	92	40	77	92	100	68	96	100	100	90	—	—	100	52	48	81	96	56
1961–1962	14	22	94	33	84	79	80	75	99	—	100	100	1	34	96	78	54	60	91	54
1962–1963	2	0	64	21	41	36	53	43	49	64	—	43	2	0	28	9	25	25	52	31
1963–1964	0	2	95	—	46	86	79	—	76	63	93	—	5	—	—	—	45	65	88	—
1960–1964	6	37	88	35	64	83	86	66	82	86	98	81	2	25	80	53	43	72	88	52
Forbs																				
1960–1961	100	43	8	50	23	8	T	29	4	0	0	9	—	—	0	40	51	19	4	38
1961–1962	85	14	2	52	16	16	17	23	1	—	0	0	99	41	4	4	45	23	6	32
1962–1963	98	98	32	40	59	63	47	27	51	34	—	57	98	100	27	4	75	74	36	33
1963–1964	100	98	4	—	54	14	21	—	23	37	6	—	95	—	—	—	54	35	12	—
1960–1964	94	45	10	49	36	15	14	26	18	14	2	19	98	56	8	28	56	23	10	35

very minor and varied in relation to availability of sweetclover. Prairie aster, *Aster commutatus* (T & G) Gray, and common salsify were most consistently and widely taken. Wild licorice was grazed intensively early in the period but largely on the minor *Agropyron–Symphoricarpos* habitat type. Other forbs occasionally receiving important use were cudweed sagewort, *Artemisia ludoviciana* Nutt., and eriogonum, *Eriogonum multiceps* Nees, during October, and Hood's phlox in November.

Browsing increased from summer and predominated on all types combined as well as on the *Agropyron–Symphoricarpos*, *Agropyron–Poa*, *Artemisia longifolia*, and timbered habitat types. Overall, usage of skunkbrush sumac, green rabbitbrush, snowberry, and yellow sweetclover was about equal. Skunkbrush was browsed at intensities similar to summer during September and early October. Subsequent use was minor but varied in relation to prior, summer–early fall utilization and/or relative occurrence of deer on the *Pinus–Juniperus* habitat type. Trends in feeding on the other deciduous shrubs generally paralleled use on skunkbrush sumac, except that deer browsed snowberry intensively on both timbered types throughout the period as

TABLE 27.—COMPARISON OF RELATIVE INTENSITIES OF MULE DEER USE ON SOME IMPORTANT FORAGE PLANTS DURING SEASONS AND YEARS 1960–1964. DATA ARE PERCENTAGES OF THE TOTAL INSTANCES OF PLANT USE RECORDED FOR EACH PERIOD. TRACE (T) AMOUNTS ARE LESS THAN 1%

Taxon	1960–1961				1961–1962				1962–1963				1963–1964			
	Sum	Fall	Wtr	Spr	Sum	Fall	Wtr	Spr	Sum	Fall	Wtr	Spr	Sum	Fall	Wtr	Spr
Melilotus officinalis	45	13	0	T	36	1	0	T	58	62	19	14	37	24	7	—
Rhus trilobata	29	20	6	6	36	6	7	2	10	9	T	4	22	23	3	—
Symphoricarpos spp.	10	15	10	6	10	13	2	1	8	9	1	3	14	8	11	—
Chrysothamnus spp.	0	27	19	1	0	19	9	5	0	0	28	4	0	5	34	—
Artemisia tridentata	0	4	33	27	0	3	49	24	0	0	13	16	0	0	18	—
Juniperus scopulorum	0	T	9	6	T	7	16	18	0	0	3	4	0	T	2	—
Total Number of Plant Taxa Used	21	20	20	45	30	37	24	50	34	15	31	41	26	21	19	10

well as on *Agropyron–Symphoricarpos* during September and early October. Increased utilization of rabbitbrushes and sagebrushes as availability and feeding on deciduous shrubs and forbs decreased during early fall represented one of the major seasonal changes in the yearlong food habits of mule deer on the area. Although green rabbitbrush received rather intensive use on both timbered types as well as on *Sarcobatus–Agropyron* and *Agropyron–Symphoricarpos*, it was abundant only on the latter type. There was some evidence to suggest that the taxon had been more abundant, rather widely distributed, and probably of greater importance in previous years. Rubber rabbitbrush, which was abundant, widely distributed, and intensively browsed on the *Artemisia–Agropyron* type, appeared to be much more important during this study and may have been the single most important plant for feeding during October and November. Both rabbitbrushes usually were eaten only after flowering. Also, previously browsed "leaders" appeared to be more preferred than those which held seedheads. Several other shrubs were added to the diet of mule deer during this period, such as longleaf sagebrush which received very intensive use during September on the *Artemisia longifolia* and *Pinus–Artemisia* associations, silver sagebrush which received minor usage during October and November, and big sagebrush in November.

Utilization of grass during fall varied considerably but was generally minor except during 1961. Intensive grazing was restricted to Sandberg bluegrass during October and November and was related to fall precipitation and green-up.

Winter

A total of 62 mule deer feeding sites was examined: 1961, 32; 1962, 16; 1963, 9; and 1964, 5. Feeding was recorded on 39 taxa including 14 forbs, 16 shrubs, and 9 grasses. Fifteen of these, 4 forbs, 10 shrubs, and 1 grass, each received more than 1% of the total instances of use during winter.

Shrubs, collectively, and big sagebrush, individually, constituted the primary forage of mule deer during winters, comprising 88% and 33%, respectively, of the total seasonal use. The relatively low incidence of browsing in 1963 reflected unusual abundance and utilization of forbs. A sharp increase in feeding on big sagebrush and Rocky Mountain juniper at the onset of winter characterized a second major seasonal change in the food habits of deer. The former prevailed as the single most important taxon throughout most winters, but was browsed most intensively during midwinter and periods of snow cover. Utilization of rubber rabbitbrush, which ranked second among all taxa, was most intensive in early winter and declined to minor levels late in the period. Rocky Mountain juniper ranked third, but generally was of only minor or moderate importance. It appeared to be taken consistently in association with feeding on big sagebrush, but also was browsed intensively when deer moved onto the *Pinus–Juniperus* type during periods of heavy snow and cold temperatures. Snowberry and skunkbrush sumac were eaten frequently, though in minor amounts, on the *Pinus–Juniperus* habitat throughout the winter. Use of other shrubs usually was very minor or occasional. Feeding on green rabbitbrush occurred mostly on the little-used *Pseudotsuga–Juniperus* and *Sarcobatus–Agropyron* habitat types. Occasional heavy browsing of Nuttall saltbush, *Atriplex nuttallii* Wats, greasewood, Douglas fir, and ponderosa pine occurred on some sites during some winters.

Collectively, forbs were of little importance. Greatest use occurred during 1963. Taxa eaten most consistently were yellow sweetclover, common salsify, fringed sagewort, *Artemisia frigida* Willd., and Hood's phlox. Deer fed relatively intensively on the latter during snow-free periods and in February. None of these plants received more than 3% of the total winter use.

Winter utilization of grasses was very minor but varied in relation to green-up and snow cover. The highest incidence of graz-

TABLE 28.—FREQUENCY OF OCCURRENCE (F) AND VOLUME PERCENTAGES (V) OF PLANT TAXA AND FORAGE CLASSES AMONG SAMPLES OF CONTENTS OF RUMENS OF 37 MULE DEER. OMITTED ARE 20 FORBS AND 1 SEDGE WITH VOLUME PERCENTAGES LESS THAN 1.0% FOR ANY SEASON. NUMBERS OF SAMPLES ARE IN PARENTHESES. TRACE (T) AMOUNTS ARE LESS THAN 1%

Taxa	Summer	Fall (Oct–Nov)				Winter			Spring
Forage Class	1963 F/V	1960 F/V	1961 F/V	1962 F/V	Total F/V	1961-1962 F/V	1962-1963 F/V	Total F/V	1963 F/V
	(6)	(1)	(6)	(10)	(17)	(4)	(4)	(8)	(6)
Gramineae Family	33/T		100/43	70/23	77/29	100/3	100/19	100/11	67/25
Grass Total	33/T		100/43	70/23	77/29	100/3	100/19	100/11	83/26
Artemisia cana				30/5	1/3	50/T		25/T	
Artemisia tridentata			100/15	10/T	41/5	100/63	100/21	100/42	83/5
Chrysothamnus spp.		100/95	83/25	70/7	77/19	75/2	75/16	75/9	33/8
Juniperus scopulorum			100/9	60/3	71/5	100/16	75/9	87/13	33/5
Prunus virginiana	83/14			10/T	5/T				17/T
Pseudotsuga menziesii			17/T	10/T	11/T	50/2		25/T	17/T
Rhus trilobata	100/26		33/T	20/T	23/T	25/T	25/T	25/T	17/T
Rosa spp.	100/13	100/T	17/T	40/1	47/T	50/T		25/T	67/15
Symphoricarpos spp.	83/2		33/T	50/3	41/1	25/T		13/T	33/2
Unidentified Browse	17/T	100/1	67/4	60/1	65/2	50/T	25/7	37/3	67/1
Browse Total	100/59	100/99	100/57	100/21	100/39	100/95	100/53	100/73	100/36
Allium textile									33/5
Aster spp.							25/5	13/3	
Cirsium spp.				20/1	11/T				
Comandra umbellatum	33/2								
Compositae Family			17/T		5/T		75/1	37/T	17/T
Leguminosae Family				10/9	5/5				
Medicago spp.				20/5	11/3		25/T	13/T	
Melilotus officinalis	100/25			30/16	17/9				67/3
Tragopogon dubius	49/7						25/5	13/3	33/4
Unidentified Forbs	67/1	100/T	67/T	100/21	88/13	50/2	75/15	63/9	83/2
Forb Total	100/36	100/T	67/1	100/54	88/32	50/2	100/28	75/27	100/30

ing was on green Sandberg bluegrass during December. Use of other grasses consisted of seedheads or was incidental to browsing.

Spring

Sixty-five feeding sites of mule deer were examined during spring, including 34 in 1961, 20 in 1962, 10 in 1963, and 1 during March 1964. The use on 67 taxa, which included 44 forbs, 16 shrubs, and 7 grasses and grass-like plants, reflected the flux in availability as well as mule deer forage preferences through the period. Twenty-one taxa, 9 forbs, 10 shrubs, and 2 grasses, each received more than 1% of the total instances of recorded use.

Browse was the most important forage class for all years combined largely because of intensive feeding on big sagebrush in March. Rocky Mountain juniper ranked second among shrubs and third among all taxa in seasonal use. Utilization of these and other winter browse plants, which collectively were of only very minor importance, decreased significantly during late March and April. The decline coincided with the onset of the spring green-up, and marked the third seasonal change in mule deer food habits. It was complemented by increasing utilization of grass, especially Sandberg bluegrass. Occasional grazing of western wheatgrass and junegrass also was recorded, but most of this appeared incidental to feeding on the bluegrass or to browsing. Though use on grasses was far more intensive during spring than other periods, it occurred largely in April and was generally moderate in comparison with use on other forages.

Forbs typically received only minor use during March but increased in importance during April and predominated in usage for May. Hood's phlox was the only taxon of any significance during March. Although no forb received more than 6% of the total seasonal usage, several members of the *Poa* union, wild onion, lomatium, nodding microseris, and yellowbell, were consistently

TABLE 29.—PERCENTAGES OF MULE DEER FEEDING SITES EXAMINED DURING SUMMER AND FALL ON WHICH YELLOW SWEETCLOVER WAS ABUNDANT, SCATTERED, AND ABSENT, 1960–1963

Relative Abundance	1960		1961		1962		1963	
	Summer	Fall	Summer	Fall	Summer	Fall	Summer	Fall
Abundant	59	23	30	0	61	100	90	60
Scattered	19	4	16	40	30	0	10	40
Absent	22	73	54	60	9	0	0	0

and widely eaten on the area. Feeding on this group declined and was supplanted by increasing use on taxa of the *Tragopogon* union, especially bastard toadflax, common salsify, and yellow sweetclover. Arnica, *Arnica sororia* Greene, western hawksbeard, *Crepis occidentalis* Nutt., scarlet gaura, *Gaura coccinea* Pursh, and American vetch were also heavily used at some sites. Utilization of these and several deciduous shrubs, skunkbrush sumac, rose, snowberry, and squaw currant, *Ribes cereum* Dougl., in late May resulted in the fourth major seasonal change to food habits characteristic of summer.

Discussion

Yearlong, shrubs (browse) comprised the most important source of forage for deer at feeding sites, and averaged approximately 62% of mean monthly instances of use during the 4-year period. Browsing was minimal in late April and early May, increased gradually through summer and sharply during fall to a maximum in January, then decreased through March and April. Forbs ranked second and comprised about 32% of the total instances of plant use. Trends in yearlong use complemented those for browse. Maximum usage occurred in early May, the minimum in January. Grasses and grass-like plants were of minor importance overall, comprising only about 6% of the mean monthly instances of plant use. Grazing of grasses and grass-like plants was negligible during summer and early fall, increased late in the period during years of green-up, declined to a minimum during midwinter, increased sharply to a maximum in early April, and decreased to summer levels by mid-May.

Analyses of ruminal contents of 37 mule deer (Table 28) generally supported data from feeding sites on seasonal and yearlong use of both forage classes and individual taxa. Some discrepancies reflected the influence of a large volume of an item in a sample (rose in spring) and concentration of collections in periods of exceptionally intensive or unusual use of an item (grass in fall and winter 1963). The predominance of browse, including the slightly greater volume of skunkbrush sumac in the contents of rumens collected during summer, may represent a truer relationship between forbs and shrubs in the mule deer diet than feeding site examinations. Numbers of feeding site examinations corresponded generally to the observed occurrence of mule deer on the various habitat types. This, together with the predominant use of browse on timbered types, was also evidence of greater than observed browsing in summer.

Generally similar trends in food habits of mule deer in the Missouri River Breaks of Valley County, Montana, were reported by Trueblood (1960). Janson and Picton (1959:29) found Douglas fir and rabbitbrush to be the principal items in samples of contents of rumens from 14 mule deer collected during February 1958 in the Missouri River Breaks of Fergus County, west of the present study area. Allen (1968:139) found alfalfa in summer and kochia, *Kochia scoparia* (L.) Sch., in winter to be the most-used plants on mule deer feeding sites on bottomlands along the Missouri River on the present study area.

The extensive differences in precipitation during the 4 years significantly influenced plant growth, forage conditions, and mule deer food habits on the study area. Changes in availability of forbs, especially

TABLE 30.—SEASONAL FREQUENCIES AND AGGREGATE MEAN PERCENTAGES OF USE OF PLANT TAXA BY ELK AT FEEDING SITES ON RANGELAND HABITAT TYPES IN THE MISSOURI RIVER BREAKS, MONTANA (SEE TEXT). TRACE (T) AMOUNTS ARE LESS THAN 1%. NUMBERS IN PARENTHESES ARE THE NUMBER OF FEEDING SITES EXAMINED AND THE TOTAL NUMBER OF TAXA USED ON THE TYPE DURING THE SEASON, RESPECTIVELY

Habitat Type	Summer		Fall		Winter		Spring	
Plant Taxa	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use
Artemisia–Agropyron Type	(12-26)		(17-27)		(17-19)		(19-29)	
Agropyron smithii	42	13	88	43	100	70	100	54
Koleria cristata	33	6	82	17	71	8	53	4
Poa secunda	17	T	76	10	76	5	90	20
Grass Total	67	23	100	81	100	86	100	81
Melilotus officinalis	92	59	18	7	12	T	21	2
Forb Total	100	77	53	13	35	2	90	13
Artemisia tridentata			18	2	41	10	58	6
Browse Total	8	T	29	6	47	11	58	6
Pinus–Juniperus Type	(15-35)		(9-19)		(11-22)		(5-16)	
Agropyron smithii	33	13	44	24	91	64	100	49
Muhlenbergia cuspidata	13	T	56	11	18	1		
Stipa viridula	20	T	22	T	36	2	60	14
Grass Total	47	18	89	45	91	78	100	77
Arnica sororia							20	11
Melilotus officinalis	87	62	22	20	9	T		
Forb Total	100	74	44	22	46	6	40	13
Juniperus scopulorum			11	11	36	3	20	5
Symphoricarpos spp.	33	3	44	10	27	5		
Artemisia longifolia	7	T	11	11	9	1	20	T
Browse Total	47	8	56	32	73	17	40	10
Pseudotsuga–Juniperus Type	(10-24)		(3-12)		(1-16)			
Agropyron smithii	10	T	67	22	100	3		
Grass Total	40	T	67	31	100	5		
Artemisia ludoviciana			33	16				
Melilotus officinalis	60	26			100	2		
Forb Total	70	32	67	18	100	5		
Chrysothamnus viscidiflorus					100	13		
Juniperus scopulorum					100	12		
Prunus virginiana	80	37	33	2				
Pseudotsuga menziesii					100	19		
Symphoricarpos spp.	100	21	33	14	100	T		
Artemisia tridentata			33	33	100	42		
Browse Total	100	67	68	51	100	90		
Sarcobatus–Agropyron Type	(4-13)		(3-7)		(8-16)		(3-16)	
Agropyron smithii	25	20	33	30	75	57	100	61
Poa secunda			100	40	62	16	68	25
Grass Total	50	25	100	73	88	77	100	86
Melilotus officinalis	100	69	33	2				
Forb Total	100	73	33	2	25	1	100	11
Chrysothamnus viscidiflorus			33	17				
Artemisia cana					12	12		
Browse Total	50	2	67	25	62	22	67	2
Agropyron–Symphoricarpos Type	(13-25)		(5-14)				(4-18)	
Agropyron smithii	36	2	60	20			100	62
Poa compressa			20	7			75	15
Grass Total	43	3	100	36			100	84
Aster commutatus	14	T	40	12				
Glycyrrhiza lepidota	100	34	60	12				
Helianthus maximilliana	7	T	20	10				
Melilotus officinalis	93	53	40	15			50	T
Forb Total	100	94	80	59			75	16
Browse Total	50	3	40	5				

TABLE 30.—*Continued*

Habitat Type / Plant Taxa	Summer		Fall		Winter		Spring	
	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use
Xanthium Type	(7-18)		(1-2)		(1-4)		(2-10)	
Agropyron smithii	33	4					100	59
Distichlis stricta					100	12		
Grass Total	33	6			100	12	100	93
Glycyrrhiza lepidota	83	37	100	60	100	12	50	1
Melilotus officinalis	100	46	100	33			50	4
Xanthium strumarium	33	T			100	60		
Forb Total	100	92	100	100	100	71	50	7
Artemisia longifolia	17	T			100	17		
Browse Total	67	3			100	17		
Artemisia longifolia Type	(3-10)							
Lactuca serriola	67	24						
Melilotus officinalis	100	57						
Forb Total	100	100						
Agropyron–Poa Type			(5-13)					
Agropyron smithii			100	13				
Poa secunda			100	57				
Grass Total			100	74				
Melilotus officinalis			60	22				
Forb Total			100	24				
Browse Total			20	T				
All Types Combined	(64-71)		(43-45)		(38-39)		(33-50)	
Agropyron smithii	30	8	70	30	90	62	100	55
Agropyron spicatum	8	T	9	T	37	1	15	2
Bouteloua gracilis	5	T	30	2	18	T	3	T
Koleria cristata	14	2	58	8	45	6	36	3
Muhlenbergia cuspidata	9	T	40	3	32	T	6	T
Poa compressa	2	T	5	T			12	2
Poa secunda	8	T	63	15	66	6	76	15
Stipa viridula	12	T	28	2	18	T	39	4
Grass Total	45	11	93	62	95	78	100	82
Allium textile							52	2
Arnica sororia							3	2
Artemisia ludoviciana			2	1	5	T		
Aster commutatus	23	T	19	3	18	T	6	T
Glycyrrhiza lepidota	36	11	9	3	3	T	3	T
Helianthus maximilliana	5	T	2	1				
Lactuca serriola	8	1						
Lomatium foeniculaceum	2	T					36	2
Melilotus officinalis	88	53	28	12	10	T	21	1
Microseris nutans	12	2					30	T
Tragopogon dubius	28	1	14	T	10	T	24	T
Xanthium strumarium	3	T			3	2		
Forb Total	95	75	60	23	40	5	79	13
Artemisia cana					8	3		
Artemisia longifolia	6	T	2	2	5	T	3	T
Artemisia tridentata			12	3	37	8	42	4
Chrysothamnus viscidiflorus	2	T	12	2	5	T		
Juniperus scopulorum			7	3	13	1	3	T
Prunus virginiana	14	6	2	T	3	T		
Rhus trilobata	14	1	2	T	13	T	3	T
Symphoricarpos spp.	34	4	16	3	10	2		
Browse Total	48	14	44	15	60	17	46	5

yellow sweetclover (Table 29), were closely reflected in seasonal intensities of use of forage classes and certain taxa. These phenomena were most pronounced in the contrasting 1961–1962 and 1962–1963 periods. During the former, summer–fall abundance and utilization of sweetclover and other forbs was lowest and the intensity of browsing was much higher in early summer than other years. As a result, availability decreased sharply after midsummer such that late summer and early fall use of "summer" browse plants was very minor and was supplanted by early, intensive utilization of

TABLE 31.—PERCENTAGES OF GRASS, BROWSE, AND FORBS UTILIZED BY ELK AT FEEDING SITES ON HABITAT TYPES WHICH RECEIVED AT LEAST 10% OF THE TOTAL ELK USE DURING AT LEAST ONE SEASON BY SEASON AND YEAR 1960–1964. TRACE (T) AMOUNTS ARE LESS THAN 1%

Forage Class	*Artemisia–Agropyron*				*Pinus–Juniperus*				*Pseudotsuga–Juniperus*				*Sarcobatus–Agropyron*				All Types Combined			
	Sum	Fall	Wtr	Spr	Sum	Fall	Wtr	Spr	Sum	Fall	Wtr	Spr	Sum	Fall	Wtr	Spr	Sum	Fall	Wtr	Spr
Grass and Grass-like																				
1960–1961	9	92	97	85	0	61	76	80	1	31	—	—	7	63	75	85	2	64	82	82
1961–1962	71	81	69	71	65	31	82	74	0	—	—	—	88	—	75	88	44	67	75	79
1962–1963	4	41	64	83	T	8	—	—	T	—	5	—	0	93	—	—	T	44	44	86
1963–1964	5	69	82	—	13	—	79	—	2	—	—	—	—	—	90	—	4	69	83	—
1960–1964	23	81	86	81	18	45	78	77	T	31	5	—	25	73	77	86	11	62	78	82
Browse																				
1960–1961	0	3	T	4	9	19	16	0	92	51	—	—	2	37	25	4	20	16	11	3
1961–1962	0	11	31	12	T	66	18	25	100	—	—	—	4	—	22	T	16	22	24	11
1962–1963	0	0	34	4	15	0	—	—	31	—	89	—	0	T	—	—	9	T	53	3
1963–1964	T	22	16	—	0	—	16	—	12	—	—	—	—	—	10	—	3	22	14	—
1960–1964	T	6	11	6	8	33	17	10	67	51	90	—	2	25	22	2	14	15	17	5
Forbs																				
1960–1961	91	5	3	11	91	20	8	20	7	18	—	—	91	0	0	11	78	20	7	15
1961–1962	29	8	T	17	35	3	T	1	T	—	—	—	8	—	3	11	40	12	1	10
1962–1963	96	59	2	13	84	92	—	—	69	—	6	—	100	7	—	—	90	56	3	10
1963–1964	95	9	2	—	87	—	5	—	86	—	—	—	—	—	0	—	93	9	3	—
1960–1964	77	13	2	13	74	22	6	13	32	18	6	—	73	2	1	11	75	23	5	13

"fall" browse. Subsequently, with decreasing availability of rabbitbrush, big sagebrush and Rocky Mountain juniper received unseasonable, intensive use in October. Winter use of both was also relatively high as compared to other years, and browsing on most other "preferred" plants was low. Forbs were only moderately abundant during early summer in 1962, but availability increased greatly in late summer and fall following germination and growth of first-year stems of yellow sweetclover. The latter was eaten intensively during summer and fall and moderately in winter on the timbered habitat types where it persisted in relative abundance. Utilization of deciduous shrubs decreased significantly during summer as compared to previous years. Fall use was not detected on rabbitbrush, big sagebrush, or Rocky Mountain juniper at feeding sites, though minor percentages of rabbitbrush and juniper as well as a trace percentage of big sagebrush occurred in the contents of 10 rumens collected during the period (Table 28). Significantly, utilization of rabbitbrush during winter increased greatly, and browsing on big sagebrush and Rocky Mountain juniper decreased. The repeated occurrence of the same phenomena under somewhat similar conditions during the following winter suggested that both big sagebrush and Rocky Mountain juniper were only secondarily preferred winter forage plants. Their importance during the winters of 1960–1961 and 1961–1962 may have been exaggerated as a result of excessive fall utilization of rabbitbrush and other more preferred shrubs. Green-ups influenced by heavy precipitation in early October 1961 and late October 1962 were followed by extensive feeding on grasses during fall and winter. This certainly affected utilization of rabbitbrush and may have influenced use of other taxa during these periods. Early green-up and growth of Sandberg bluegrass was reflected in increased grazing and decreased browsing during March 1963 as compared with other years. In addition to these relationships, the number of taxa utilized by mule deer appeared to vary inversely with forage conditions (Table 27). The number of taxa eaten was greatest during spring and fall of the driest years when seasonally preferred plants were least abundant.

TABLE 32.—RELATIVE INTENSITIES OF ELK USE OF SOME IMPORTANT FORAGE PLANTS DURING SEASONS AND YEARS 1960–1964. DATA ARE PERCENTAGES OF THE TOTAL INSTANCES OF PLANT USE RECORDED FOR EACH PERIOD. TRACE (T) AMOUNTS ARE LESS THAN 1%

Taxa	1960–1961				1961–1962				1962–1963				1963–1964			
	Sum	Fall	Wtr	Spr	Sum	Fall	Wtr	Spr	Sum	Fall	Wtr	Spr	Sum	Fall	Wtr	Spr
Melilotus officinalis	65	6	0	T	9	T	0	T	56	56	T	5	85	8	1	—
Prunus virginiana	10	T	2	0	7	0	0	0	3	0	0	0	0	0	0	—
Symphoricarpos spp.	5	6	2	0	6	T	0	0	3	0	0	0	T	0	0	—
Agropyron smithii	T	40	65	68	32	24	58	41	T	1	26	32	T	67	77	—
Poa secunda	4	6	9	12	T	24	2	11	T	33	4	33	T	1	1	—
Artemisia tridentata	0	4	T	2	0	2	17	8	0	0	34	T	0	22	8	—
Total Number of Plant Taxa Used	31	32	21	39	36	25	17	19	39	14	15	8	33	7	20	—

Elk

A total of 28,030 instances of plant use by elk was recorded at 178 feeding sites between June 1960 and January 1964. The number of instances at each site ranged from 50 to 750 but usually was between 100 and 200. The average number was 157. The smallest samples occurred in late spring and early summer when single individuals and small groups of elk were common.

Data on usage of plant taxa, which received at least 10% of the total seasonal instances of use on at least one habitat type or 1% of the total for all types combined over the 4 years, are presented in Table 30. Relative seasonal and yearly intensities of use of forage classes and individually important forage plants are presented in Tables 31 and 32, respectively.

Summer

Sixty-four elk feeding sites were examined, including 23 in 1960, 14 in 1961, 19 in 1962, and 8 during 1963. Feeding was observed on 71 taxa, including 49 forbs, 10 shrubs, and 12 grass and grass-like plants. Ten of these, 5 forbs, 3 shrubs, and 2 grasses, each received an average of more than 1% of the total instances of use for the 4 summers.

Forbs were the most important source of forage on all but the *Pseudotsuga–Juniperus* habitat type and comprised 75% of the total combined use for the period. Yellow sweetclover was the most important taxon, accounting for more than two-thirds of the use on forbs and slightly more than half of the summer total. It was eaten on 88% of all elk feeding sites. Wild licorice ranked second among all taxa and was especially important on the *Agropyron–Symphoricarpos* type which received intensive use by elk during July and August. Prairie aster, prickly lettuce, *Lactuca serriola* L., nodding microseris, and common salsify received minor usage, largely during June; and bastard toadflax, Maximilian sunflower, *Helianthus maximiliani* Schrad., and purple prairie-clover, *Petalostemum purpureum* (Vent.) Rybd., were utilized to a minor extent later in the period.

Shrubs comprised about 15% of the total summer use. Utilization was largely on the *Pseudotsuga–Juniperus* type during July and, especially, August. Browsing appeared to be more extensive during the drought summers of 1960 and 1961 as compared to 1962 and 1963. Chokecherry was the most important shrub and ranked third among all taxa. Snowberry ranked second receiving consistent though minor usage throughout the period. Skunkbrush sumac received only minor use overall, but was eaten on both timbered habitats. Rose and currant also received minor usage largely on the *Pseudotsuga–Juniperus* type. Elk, like mule deer, browsed mainly on leaves until late summer when twigs became more important.

Grasses constituted only minor percentages of the seasonal use except during 1961 when they were the principal source of elk forage. Western wheatgrass was the most

important taxon. It ranked third among all taxa only because of exceptionally heavy use during 1961. Junegrass received only minor use, primarily on the *Artemisia–Agropyron* and *Pinus–Juniperus* habitat types. Other grasses and grass-like plants were eaten only occasionally or to a very minor extent.

Fall

The 43 elk feeding sites examined during fall included 23 in 1960, 12 in 1961, 7 in 1962, and 1 during November 1963. Use was recorded on 45 taxa, including 18 forbs, 11 shrubs, and 16 grasses and grass-like plants. Sixteen of these, 5 forbs, 5 shrubs, and 6 grasses, each received more than 1% of the total instances of use.

Grazing on grasses increased significantly over summer, representing a major change in the diet of elk on the area during 3 of the 4 years. The change occurred in late September when elk began grazing on plains muhly, junegrass, Sandberg bluegrass, and occasionally other grasses, and feeding on forbs and deciduous browse decreased. Subsequently, use of western wheatgrass increased very sharply during October to predominate through the remainder of the period. Overall, grasses constituted about 62% of the recorded use and were important on all but the minor *Xanthium* habitat type. Western wheatgrass, the most important taxon, individually comprised about 30% of the total though it was utilized largely during October and November. Sandberg bluegrass ranked second among grasses for the entire period but was eaten most intensively when green, and on the *Agropyron–Poa* type in late fall. Junegrass, the only other grass of importance in the fall diet, also was grazed intensively only when green. Plains muhly made only a minor contribution overall, but was the most important grass for feeding during September. Other grasses and grass-like plants were eaten only occasionally.

Forbs continued as the most important source of forage during September but ranked second to grasses for the entire period. Yellow sweetclover persisted as the most important plant receiving moderate usage throughout fall when either first-year stems or dry seed stalks were available. Wild licorice and prairie aster were about equally preferred to sweetclover during September but received only minor use later. Other forbs individually contributed very little to the fall forage of elk.

Shrubs appeared to be of relatively minor importance in the diet. Browsing accounted for about 15% of the seasonal use overall but was intensive only in September. It was rarely detected at feeding sites examined during the fall of 1962. Snowberry and green rabbitbrush were the most consistent, though generally minor, browse items. Chokecherry, skunkbrush sumac, and longleaf sagebrush were important in the diet during September but were rarely browsed during other periods. Big sagebrush and, occasionally, Rocky Mountain juniper were utilized to a minor extent in late fall of some years.

Winter

Data were obtained at 38 elk feeding sites: 22 in 1961, 9 in 1962, 3 in 1963, and 4 in 1964. Thirty-nine taxa, including 14 forbs, 13 shrubs, and 12 grasses or grass-like forms, were eaten. Nine of these, 1 forb, 4 shrubs, and 4 grasses, each comprised more than 1% of the total combined winter usage.

Grass was by far the predominant forage class, of which western wheatgrass, comprising 62% of the seasonal use, and Sandberg bluegrass and junegrass, which ranked second and third, respectively, were the major items. The latter taxa were grazed most heavily when green and available early and late in the period. Bluebunch wheatgrass was eaten relatively frequently but in minor amounts. All other grasses were grazed only occasionally.

Shrubs were of moderate importance constituting about 17% of the total combined instances of plant use for winter. Nearly half of this was on big sagebrush which was browsed moderately throughout the period. Other shrubs were eaten only occasionally or in minor amounts, primarily during De-

cember and January. Increased utilization of big sagebrush, silver sagebrush, Rocky Mountain juniper, and snowberry in midwinter reflected more extensive browsing during periods of snow cover. Rouse (1957, unpublished master's thesis, Montana State University, Bozeman, Montana) reported important usage of shrubs by elk in winter only during periods of severe cold and snow cover.

Forbs received only incidental or occasional usage and were never important in the winter diet of elk on the area.

Spring

A total of 33 elk feeding sites was examined during spring: 19, 9, and 5 for 1961, 1962, and 1963, respectively. Fifty taxa, including 34 forbs, 5 shrubs, and 11 grasses and grass-like plants, were utilized. Eleven of these, 4 forbs, 1 shrub, and 6 grasses, each received 1% or more of the total recorded usage.

Grass continued from winter as the predominant forage for elk, constituting approximately 82% of the seasonal instances of plant use. Western wheatgrass individually comprised about 50% of the total. Sandberg bluegrass was grazed moderately and was the second most important source of forage throughout the period. Other grasses receiving minor usage included bluebunch wheatgrass in March, green needlegrass in March and April, Canada bluegrass in April on the *Agropyron–Symphoricarpos* habitat type, and junegrass throughout the period. Foraging on grasses generally decreased monthly through spring, coinciding with increased availability and usage of forbs to mark the second major change in the yearlong food habits of elk on the area.

Forbs, collectively, received only minor use during March of most years, increased in relative importance throughout April, and were fed on intensively during late May as the class became the primary source of forage and food habits became characteristic of summer. Although no taxon individually comprised more than 2% of the total seasonal use, several members of the *Poa* union, especially wild onion, lomatium, and nodding microseris, were utilized extensively during April and May. Foraging on this group declined after mid-May as a number of forbs of the *Tragopogon* union, including arnica, bastard toadflax, blue lettuce, *Lactuca pulchella* (Pursh) DC., yellow sweetclover, common dandelion, *Taraxacum officinale* Weber, common salsify, and American vetch, became preferred food items.

Browse made up only about 5% of the spring diet and consisted largely of big sagebrush which received moderate usage during March and early April and Rocky Mountain juniper which was eaten occasionally during March. Browsing was negligible during May.

Discussion

Yearlong, grasses were the most important source of forage for elk, averaging 58% of the mean monthly instances of plant use for the 4-year period. Foraging on grasses normally was lowest during summer and increased sharply in early fall, when grass became the predominant food, then gradually through late fall and early winter to the yearly maximum in February through mid-April before declining to relatively low levels by early June. Usage of forbs, which ranked second overall and averaged 29% of the mean monthly instances of use, generally complemented trends for grass. Forbs were the most important class of plant in the diet in summer and decreased sharply in early fall and gradually through late fall to a minimum in February, then increased slightly during March and rapidly through April and May to maximal summer levels in June. Overall use of shrubs was only moderate comprising 13% of the total. Browsing varied only slightly between seasons; it was least intensive during late April and early May when only occasional feeding occurred on shrubs and at a yearly maximum in January when moderate usage was recorded.

Although the number of ruminal samples

TABLE 33.—FREQUENCY OF OCCURRENCE (F) AND VOLUME PERCENTAGES (V) OF PLANT TAXA AND FORAGE CLASSES AMONG SAMPLES OF CONTENTS OF RUMENS OF 12 ELK. OMMITTED ARE 4 SHRUBS AND 9 FORBS WHICH HAD A VOLUME OF LESS THAN 1.0% FOR ANY SEASON. NUMBERS OF SAMPLES ARE IN PARENTHESES. TRACE (T) AMOUNTS ARE LESS THAN 1%

Taxa Forage Class	Summer 1963 V	Fall 1961 F/V	Fall 1962 V	Fall 1963 F/V	Fall Total F/V	Winter 1963 V	Spring 1963 V
	(1)	(5)	(1)	(3)	(9)	(1)	(1)
Grass Total		100/87	98	100/24	100/68	97	82
Artemisia frigida				33/6	11/2	T	
Melilotus officinalis	96			100/15	33/5		10
Solidago sp.				33/3	11/T		
Yucca glauca				67/2	22/T		
Unidentified Forbs	T	60/T	T		44/T	2	1
Forb Total	97	60/1	T	100/26	66/8	2	12
Artemisia cana		20/T		33/11	22/6		
Artemisia longifolia				33/4	11/1		
Artemisia tridentata		80/6	T		55/3	T	
Chrysothamnus spp.		40/1		67/17	44/6		
Prunus virginiana	1			33/13	11/4		T
Rosa spp.	1	40/T		33/T	33/T		T
Symphoricarpos spp.	T			100/2	33/T		1
Unidentified Browse	T	60/4	T	67/T	66/2	T	4
Browse Total	3	100/12	1	100/48	100/24	1	6

obtained from elk was small, analyses generally supported the feeding site data (Table 33). The only important discrepancy was in the larger proportion of shrubs in the fall samples, which suggested that browsing may have been more extensive than indicated by feeding site examinations, at least during some years.

Yearlong trends in elk food habits reported for other studies vary among areas in relation to vegetational characteristics and/or seasonal availability of the various forage classes and plant taxa. Generally, as reported here, the results have indicated preference for forbs and leaves of deciduous shrubs during summer. Extreme differences have been reported for winter, e.g., differences in relative utilization of grass and browse ranging from more than 99% grass (Morris and Schwartz 1957:192) to 90% browse (Young 1938:131). Lovaas (1963:11) presented data showing relative usage of forage classes by elk ranging from 69% grass and 23% browse during an open winter to 9% grass and 91% browse during a severe winter as evidence of elk preference for grass when available. The intensive feeding on grass by elk in early fall when summer browse remained available, as well as during winter, indicated that the importance of grass in the fall–winter–spring diet of elk in the Missouri River Breaks resulted from seasonal preference for that class of forage.

As with mule deer, yearly differences in precipitation and plant growth had considerable influence on elk food habits, including relative usage of both forage classes (Table 31) and individual taxa (Table 32). The most important difference occurred during the summer of 1961 when yellow sweetclover (Table 29) and other forbs were least abundant and grasses, especially western wheatgrass, became the principal source of elk forage. Elk also appeared to browse more intensively during 1960, when the decrease in forbs was reflected in increased use of shrubs rather than grass at feeding sites, and during the summer of 1961, when shrubs were heavily browsed during June and only rarely in late summer as occurred in other years. The extreme abundance of forbs during the summer and fall of 1962 as well as the spring and summer

of 1963 was reflected in increased feeding on plants of that forage class, especially yellow sweetclover, and decreased browsing as compared to earlier years. Feeding on grass also declined during the fall of 1962 coincident with intensive feeding on sweetclover.

Some yearly variation in fall food habits of elk was also influenced by the availability of green herbage on Sandberg bluegrass, which increased sharply in the diet as western wheatgrass declined following green-ups during October of 1961 and 1962. The decrease in grazing and increased browsing at feeding sites during the winter of 1962–1963 was influenced by especially persistent snow cover and cold temperatures during January and early February.

Cattle

One hundred and eighty-three cattle feeding sites were examined between April 1961 and January 1964, mostly during the April–November grazing season. Feeding sites were examined during winter only when cattle were ranging freely on upland pastures and feeding on range forage. The number of instances of plant use recorded at each site ranged from 60 to 780 but typically was between 200 and 300 (average 237); the total number for all sites was 43,655.

Data on usage of plant taxa, which received at least 10% of the total seasonal instances of use on at least 1 habitat type or 1% of the total for all types combined over the 4 years, are presented in Table 34. Relative seasonal and yearly intensities of use of forage classes and several individually important forage plants are presented in Tables 35 and 36, respectively.

Summer

Ninety-one feeding sites were examined during 3 summers: 23, 30, and 38 for 1961, 1962, and 1963, respectively. Cattle were recorded as feeding on 95 taxa, including 62 forbs, 10 shrubs, and 23 grasses and grass-like plants. Eleven of these, 3 forbs, 1 shrub, and 7 grasses, each received an average of 1% or more of the total combined instances of plant use for summer.

Grasses were the most important source of forage overall constituting about 64% of the seasonal use, but utilization varied greatly between years apparently in relation to the abundance of forbs. Western wheatgrass, the single most important taxon overall and for all but the summer of 1963, was eaten on 99% of the feeding sites, and comprised about 40% of the seasonal use for all types combined. Plains muhly ranked second among grasses and third among all taxa but was eaten on less than half the feeding sites while receiving moderate usage on the *Artemisia–Agropyron* type and some minor usage on *Pinus–Juniperus* habitats. Green needlegrass was utilized rather consistently on two-thirds of all feeding sites but never was an important food item. It was grazed intensively only on the *Pinus–Juniperus* type during late summer. Other grasses were grazed sparingly or on minor habitat types. Blue grama was perhaps the most important as a result of frequent utilization on the *Artemisia–Agropyron* type during early summer and again in August.

Forbs ranked second, except during the summer of 1963 when they appeared to be the most important forage for cattle. The class was especially prominent in the diet during July and August. Yellow sweetclover accounted for 26% of the combined summers' use to rank as the most important forb and second among all taxa. The incidence of use on other forbs was generally low but varied in relation to their abundance as well as the abundance of sweetclover. Bastard toadflax and American vetch were grazed consistently and of some importance especially during early summer; common salsify was frequently eaten but comprised only a small percentage of the use at any site.

Shrubs, collectively as well as individually, were of very minor importance. Greasewood, the most consistently browsed plant, made up only 1% of the total summer use. It was eaten largely on the *Sarcobatus–Agropyron* type. Skunkbrush sumac and snowberry were browsed frequently, though

TABLE 34.—SEASONAL FREQUENCIES AND AGGREGATE MEAN PERCENTAGES OF USE OF PLANT TAXA BY CATTLE AT FEEDING SITES ON RANGELAND HABITAT TYPES IN THE MISSOURI RIVER BREAKS, MONTANA (SEE TEXT). TRACE (T) AMOUNTS ARE LESS THAN 1%. NUMBERS IN PARENTHESES ARE THE NUMBER OF FEEDING SITES EXAMINED AND THE TOTAL NUMBER OF TAXA USED ON THE TYPE DURING THE SEASON, RESPECTIVELY

Habitat Type / Plant Taxa	Summer		Fall		Winter		Spring	
	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use
Artemisia–Agropyron Type	(35-60)		(22-31)		(6-20)		(17-32)	
Agropyron smithii	100	35	100	47	100	55	100	53
Muhlenbergia cuspidata	65	15	61	5	17	T	5	2
Poa secunda	57	1	65	8	100	10	100	15
Grass Total	100	66	100	78	100	83	100	79
Melilotus officinalis	65	23	65	14	33	1	47	10
Forb Total	94	31	95	16	67	3	94	20
Browse Total	46	3	56	6	100	14	24	T
Agropyron–Poa Type	(5-21)		(1-5)		(1-10)		(2-7)	
Agropyron smithii	100	51	100	33	100	63	100	57
Hordeum jubatum							50	11
Poa secunda	80	T	100	63	100	6	100	13
Stipa viridula	80	10	100	T			100	13
Bouteloua gracilis	40	3			100	11		
Grass Total	100	68	100	99	100	86	100	95
Melilotus officinalis	100	24			100	10	100	2
Forb Total	100	31	100	T	100	14	100	5
Browse Total	40	1						
Pinus–Juniperus Type	(22-45)		(8-24)		(4-19)		(9-24)	
Agropyron smithii	100	37	100	57	100	32	100	45
Agropyron spicatum	45	3	75	3	75	33	44	1
Poa secunda	23	T	38	T	50	15	77	17
Stipa viridula	95	14	87	13	75	5	89	9
Grass Total	100	63	100	84	100	94	100	79
Melilotus officinalis	73	31	62	9	25	T	33	9
Forb Total	96	35	88	12	75	1	100	21
Browse Total	54	2	75	4	100	5	11	T
Pseudotsuga–Juniperus Type	(4-19)							
Agropyron spicatum	100	19						
Stipa viridula	75	13						
Grass Total	100	49						
Melilotus officinalis	75	43						
Forb Total	100	46						
Browse Total	50	4						
Sarcobatus–Agropyron Type	(7-20)		(7-25)				(4-12)	
Agropyron smithii	100	49	85	38			100	47
Poa secunda	43	3	71	13			100	34
Grass Total	100	55	85	55			100	83
Melilotus officinalis	71	31	71	19			75	8
Forb Total	85	33	100	23			100	17
Sarcobatus vermiculatus	100	11	85	19			25	T
Browse Total	100	12	85	22			25	T
Agropyron–Symphoricarpos Type	(11-35)		(4-20)				(5-22)	
Agropyron smithii	100	72	100	81			100	83
Grass Total	100	76	100	89			100	88
Melilotus officinalis	72	15	100	5			60	7
Forb Total	100	22	100	9			80	11
Browse Total	73	2	75	2			40	1

TABLE 34.—*Continued*

Habitat Type / Plant Taxa	Summer		Fall		Winter		Spring	
	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use	Percentage of Sites with Use of Taxon	Percentage of Total Instances of Use
Xanthium Type	(6-26)		(2-16)					
Agropyron smithii	100	33	100	35				
Spartina pectinata	50	10	50	2				
Grass Total	100	51	100	46				
Chenopodium album	33	3	100	15				
Melilotus officinalis	100	38	100	31				
Forb Total	100	49	100	53				
Browse Total	50	T	50	T				
Artemisia longifolia Type	(1-3)							
Agropyron smithii	100	10						
Calamovilfa longifolia	100	82						
Grass Total	100	92						
Browse Total	100	8						
All Types Combined	(91-95)		(44-60)		(11-27)		(37-48)	
Agropyron smithii	99	40	98	49	100	48	100	55
Agropyron spicatum	19	2	20	T	36	12	13	T
Bouteloua gracilis	28	3	38	3	73	5	11	1
Carex spp.	22	1	24	1	18	1	8	T
Koleria cristata	38	T	67	4	64	5	51	2
Muhlenbergia cuspidata	44	8	42	3	27	T	11	1
Poa secunda	38	T	53	8	82	11	84	16
Spartina pectinata	6	2	4	T				
Stipa viridula	65	6	76	5	54	4	62	4
Grass Total	100	64	98	76	100	87	100	82
Allium textile	2	T					57	3
Comandra umbellatum	26	1	4	T			19	T
Lomatium foeniculaceum	2	T					46	2
Melilotus officinalis	72	26	69	14	36	2	51	9
Microseris nutans	3	T					30	1
Tragopogon dubius	42	T	49	T	46	T	41	1
Vicia americana	33	1	2	T	9	T	43	1
Forb Total	94	33	96	17	73	3	95	18
Artemisia tridentata			2	T	46	2		
Chrysothamnus nauseosus	1	T	24	2	27	3	5	T
Sarcobatus vermiculatus	13	1	24	4	27	2	8	T
Browse Total	56	3	64	8	91	10	22	T

in very small amounts, on *Pinus–Juniperus* and occasionally on the *Pseudotsuga–Juniperus* type.

Fall

Data were obtained at 44 cattle feeding sites: 12 in 1961, 15 in 1962, and 17 in 1963. Sixty taxa were eaten, including 31 forbs, 10 shrubs, and 19 grasses and grass-like plants. Ten of these, 1 forb, 2 shrubs, and 7 grasses, individually received 1% or more of the total instances of plant use.

Utilization of grasses increased from summer to constitute approximately 76% of the combined instances of use for fall. Western wheatgrass remained the most important taxon; it was grazed on 98% of all feeding sites and comprised about two-thirds of the total use on grasses. Feeding on Sandberg bluegrass was relatively intensive and important, especially in October during years of fall green-up, but was minor overall. Plains muhly, blue grama, junegrass, and green needlegrass all were taken frequently,

TABLE 35.—PERCENTAGES OF GRASS, BROWSE, AND FORBS UTILIZED BY CATTLE AT FEEDING SITES ON VARIOUS HABITAT TYPES DURING SEASONS AND YEARS 1960–1963. TRACE (T) AMOUNTS ARE LESS THAN 1%

Forage Class	*Artemisia–Agropyron*			*Pinus–Juniperus*			*Sarcobatus–Artemisia*			All Types Combined			
	Spr	Sum	Fall	Spr	Sum	Fall	Spr	Sum	Fall	Spr	Sum	Fall	Wtr
Grass													
1961	90	86	97	88	92	93	—	70	35	89	87	81	90
1962	85	70	65	86	65	70	77	61	80	86	69	70	78
1963	64	45	85	62	42	89	88	38	62	73	46	80	90
1961–1963	79	66	78	79	62	84	82	55	56	82	64	76	87
Browse													
1961	T	5	T	0	5	5	—	30	39	T	6	11	9
1962	1	3	4	0	1	2	0	10	T	T	4	2	16
1963	0	T	4	T	2	7	1	5	18	T	1	6	2
1961–1963	T	3	6	T	3	4	T	12	22	T	3	7	10
Forbs													
1961	10	9	2	12	3	2	—	0	26	10	8	8	T
1962	14	26	31	14	34	28	23	29	20	13	27	28	6
1963	36	54	11	38	56	4	11	57	20	26	52	14	8
1961–1963	20	31	16	21	35	12	17	33	22	18	33	17	3

but in relatively small quantities, at feeding sites. Plains muhly and needlegrass were grazed most frequently during September; blue grama was more important in November. Other grasses were of only minor importance throughout the period.

Forbs ranked second in fall, largely because of intensive usage of yellow sweetclover, the only important plant, during 1962 and September of 1963. Other taxa were taken only occasionally or on minor habitat types.

Browsing increased from summer but remained of minor importance. Shrubs were eaten on 64% of the feeding sites and made up approximately 8% of the recorded use for fall. Only greasewood, which received minor use throughout the period, and rubber rabbitbrush, which was rather important in September, were browsed intensively. Snowberry was browsed to a minor extent on both the *Pinus–Juniperus* and the *Agropyron–Symphoricarpos* habitat types.

Winter

Eleven cattle feeding sites were examined during December and January: 6 in 1961–1962, 3 in 1962–1963, and 2 in 1963–1964. The 27 taxa utilized consisted of 9 forbs, 9 shrubs, and 9 grass and grass-like plants. Eleven of these, 1 forb, 3 shrubs, and 7 grasses, each received 1% or more of the total instances of use.

Grasses, collectively, and western wheatgrass, individually, were the most important forage sources constituting approximately 87% and 50%, respectively, of the total use

TABLE 36.—RELATIVE INTENSITIES OF CATTLE USE OF SOME IMPORTANT FORAGE PLANTS DURING SEASONS AND YEARS 1960–1963. DATA ARE PERCENTAGES OF THE TOTAL INSTANCES OF PLANT USE RECORDED FOR EACH PERIOD. TRACE (T) AMOUNTS ARE LESS THAN 1%

Taxa	1961			1962			1963		
	Spr	Sum	Fall	Spr	Sum	Fall	Spr	Sum	Fall
Melilotus officinalis	T	T	5	2	19	25	19	48	11
Agropyron smithii	58	47	45	62	48	41	48	30	61
Poa secunda	16	T	10	14	2	14	18	T	1
Total Number of Plant Taxa Used	23	44	30	32	59	33	37	69	45

for winters. Bluebunch wheatgrass ranked second among grasses but was grazed intensively only on the *Pinus–Juniperus* type and/or during periods of complete snow cover in January. Sandberg bluegrass also received moderate usage mostly during early winter in years marked by fall greenup. Blue grama, junegrass, and green needlegrass were grazed sparingly, though frequently, throughout the period.

Shrubs made up about 10% of the winter use overall but were of importance only during periods of complete snow cover as occurred during January of 1963 and briefly during other periods. Big sagebrush, which was eaten on 46% of the feeding sites, rubber rabbitbrush, and greasewood were the most important taxa, but individually were browsed to a very minor extent.

Utilization of forbs was of little importance during winter, most of that recorded was on dry stems of sweetclover.

Spring

Thirty-seven feeding sites were examined after cattle were turned onto open range in early April. This total included 10 in 1961, 12 in 1962, and 15 in 1963. Forty-eight taxa were eaten, including 28 forbs, 6 shrubs, and 14 grasses and grass-like plants. Twelve of these, 6 forbs and 6 grasses, each received an average of more than 1% of the total instances of use for spring.

Grasses, which collectively comprised 82% of the total spring use, and western wheatgrass, which individually accounted for about two-thirds of that on grasses, again continued as the most important forage sources. Western wheatgrass was eaten at all sites examined. Sandberg bluegrass, which ranked second, was moderately grazed on about 85% of the sites. Other grasses were taken only occasionally but some, especially junegrass and green needlegrass, were fed upon relatively frequently.

Forbs appeared to be only moderately important in the spring diet of cattle. Collectively, they constituted about 18% of the instances of use, but frequency of use increased progressively throughout the period. Yellow sweetclover ranked first in preference largely because of exceptional usage in 1963. All other forbs were grazed rather sparingly. Wild onion, lomatium, and nodding microseris were the most frequently eaten individual taxa during April and early May; common salsify and American vetch, in addition to sweetclover, were commonly taken in mid- and late May.

Browsing was not detected at feeding sites during the spring. This, as well as general observations, suggested that shrubs were only rarely utilized during the period.

Discussion

Grasses constituted approximately 76% of the mean monthly instances of plant use and were the most important cattle forage over the 3 years. Differences in the intensity of grazing through the year typically were minor; grazing on grasses was most intensive during April, decreased gradually to a yearly minimum in June, then increased consistently to near maximum levels by November. Grazing intensities on winter pastures were similar to November and April. Utilization of forbs by cattle complemented trends in feeding on grass. Forbs comprised about 18% of the total instances of use on feeding sites averaged for months with maximum use occurring in June and the minimum in December. Shrubs were of minor importance as browsing accounted for only 5% of the mean monthly plant use overall. Utilization was lowest in April, increased gradually through summer and early fall, and was at a maximum during October. Browsing intensities on winter pastures appeared similar to those of October.

Analyses of samples of the contents of rumens from 18 cattle showed slightly greater use of grasses during spring and summer than was indicated by feeding site examinations (Table 37). This was expected because the volume associated with an instance of use on grass was greater than for forbs and I had some difficulty in detecting use on grass where only the seed stalk was removed. Taxa found in ruminal samples

TABLE 37.—FREQUENCY OF OCCURRENCE (F) AND VOLUME PERCENTAGES (V) OF FORAGE CLASSES AND PLANT TAXA AMONG SAMPLES OF CONTENTS OF 18 CATTLE RUMENS. TRACE (T) AMOUNTS ARE LESS THAN 1%

Taxa Forage Class	Spring	Summer		
	1963 F/V	1962 F/V	1963 F/V	Total F/V
	(6)	(4)	(8)	(12)
Cyperaceae family	17/T		38/T	25/T
Gramineae family	100/90	100/92	100/71	100/78
Grass and Grass-like Total	100/90	100/92	100/71	100/78
Camelina microcarpa		25/T		8/T
Comandra umbellatum	17/T		62/T	42/T
Compositae family			12/T	8/T
Leguminosae family		25/T		8/T
Melilotus officinalis	83/10	25/T	100/26	75/18
Thlaspi arvense			12/T	8/T
Vicia americana	33/T		12/T	8/T
Unidentified forbs	33/T	75/6	38/T	50/2
Forb Total	100/10	75/6	100/27	92/20
Artemisia tridentata	50/T		62/T	42/T
Chrysothamnus viscidiflorus			12/T	8/T
Prunus virginiana			12/T	8/T
Pinus ponderosa	33/T		50/T	33/T
Rhus trilobata	33/T	25/T	62/T	50/T
Ribes cereum			12/T	8/T
Rosa spp.	33/T	25/T	38/T	25/T
Symphoricarpos spp.	17/T	25/T	38/T	25/T
Unidentified browse	100/T	75/1	100/T	92/T
Browse Total	100/T	75/1	100/2	92/2

were similar to those utilized at feeding sites.

Cattle food habits were less affected by yearly differences in precipitation and vegetational growth than those of mule deer or elk but some important variation in utilization of forage classes (Table 35) and individual taxa (Table 36) was evident. Frequency of use of grass was consistently high at cattle feeding sites throughout 1961 and the spring of 1962 when plant growth was minimal. Subsequent increased growth and availability of forbs during the summer of 1962 was directly reflected in greater representation of this forage class as well as yellow sweetclover in recorded use for the summer and fall of that year. Further increases in abundance during 1963 influenced more intensive feeding on forbs during spring, and especially summer, when forbs comprised the most important forage class, and yellow sweetclover was the most important taxon at cattle feeding sites. Comparisons of mean percentages of total forbs and sweetclover in samples of ruminal contents for 1962 and 1963 (Table 37) also showed increased grazing of those items during 1963. The greater percentages for grass than for forbs in the samples for the summer of 1963 was in contrast to data from the feeding sites. The maximum for forbs in a single sample was 82%, but in most instances, the use was between 10 and 15%. This suggested that the relative importance of forbs in the diet may have been unduly exaggerated at feeding sites.

Although differences were not extreme, the higher percentages of shrubs taken at feeding sites during 1961, compared with 1962 and 1963, suggested slightly greater browsing by cattle during periods of poor range conditions.

RANGE RELATIONS

Interspecific relations among grazing animals may connote competition in which

the welfare of one or more of the animals is adversely affected. The extent to which two species graze the same area and prefer the same forage was considered by Julander (1958:18) as the main factor controlling interspecific competition. Cole (1958a:27) listed similar criteria, but included requirements that forage plants be in limited supply or deteriorating as a result of combined usage. Smith and Julander (1953:101) differentiated the latter as "forage" competition as opposed to "land use" competition which they associated with common use of a forage species which was adequately abundant to meet the requirements of both animals, but where removal of one animal would permit increased numbers of the other. Cole (1958a:27) noted that it is not necessary that the animals use the same area or forage plants at the same time. He (Cole 1958a:29) also recognized circumstances under which certain big game species may benefit from heavy livestock grazing.

Data from the present study were evaluated with respect to those considerations which require comparisons of the distributions of animal use of the area in time and space in relation to habitat types, topography, and water sources, as well as forage preferences and the composition, abundance, and degree of utilization of forage plants.

Relations between Mule Deer and Elk

Mule deer and elk were most similar in habit between April and September when the distribution of elk overlapped the distribution of greatest mule deer densities. Both animals used the *Artemisia–Agropyron* habitat type, especially the *Artemisia–A. smithii* association, intensively during early spring. After mid-May, mule deer became concentrated on timbered areas which also received some significant summer elk use. Some forbs and Sandberg bluegrass were eaten by both animals during April and May, but grass, primarily western wheatgrass, was the most important elk forage. Forbs became important for elk as well as mule deer in late spring and summer when similar taxa were fed upon by both. Yellow sweetclover was one of the most important mule deer forage sources and the single most important elk forage from June through early September. Browse, a very important summer forage for mule deer, was of only moderate importance in the summer diet of elk. Skunkbrush sumac, the most important summer browse plant for mule deer, received only minor use by elk. Chokecherry, the most important summer browse for elk, received minor use by mule deer. Shrubs became more important for mule deer during September when grass was eaten increasingly by elk. Rubber rabbitbrush, browsed intensively by mule deer, was of little importance to elk.

Dissimilarities in range use and food habits of mule deer and elk during late fall and winter afforded less opportunity for association and conflict. Grass, the primary elk forage after September, was of little importance to mule deer. During winter, the *Artemisia–Agropyron* type was used intensively and the *Pinus–Juniperus* and *Sarcobatus–Agropyron* types received moderate usage by both animals, but food habits differed. Grass was the major item in the elk diet and browse was the most important food for mule deer. Big sagebrush, the most important winter deer forage under prevailing conditions, received only minor feeding use by elk as did Rocky Mountain juniper and snowberry which were browsed moderately or to only a minor extent by mule deer.

Although these results indicate probable conflicts between mule deer and elk, complete evaluation of the interaction requires consideration of forage conditions as well as other factors of range use.

Numbers of elk on the study area apparently were not excessive with respect to forage as indicated by the average ratio of 57 calves per 100 females for the 4-year period. Also, attempts to measure grazing of grasses on areas receiving fall or winter use by elk were unsuccessful, largely because of the lack of extended or concentrated feeding on any one site.

Mule deer, however, probably did contend with forage deficiencies and intraspecific competition during most years as a result of excessive utilization of forage. Measurements of nine utilization and condition trend sample units on skunkbrush sumac showed that an average of 58% (40 to 81% yearly) of the available leaders was eaten annually during the 4-year period. Relatively low levels of "leader use" during 1962–1963 and 1963–1964, 40 to 53%, respectively, reflected buffering by the unusual abundance and utilization of forbs during those years. Despite this, more than 80% of all plants were severely hedged. More than 95% were decadent and/or reduced to resprouts. The annual average percentage of leaders eaten on rubber rabbitbrush for six sample units was 85% (77 to 89% yearly). More than 95% of the plants were decadent by the spring of 1964. Browsing of leaders on green rabbitbrush averaged more than 80% for the 4 years on one upland site. The average percentage of leaders used on big sagebrush on five sample units was 24% (8 to 32% yearly) for the 4-year period, but feeding on this extremely abundant plant varied in relation to the availability of other forage. Chokecherry was reduced to clumps of resprouts and plants taller than 6 ft on which browse was largely unavailable to mule deer. A significant decline in abundance of this plant on the area was attested by local residents who reported chokecherry sufficiently abundant to provide large amounts of berries through the mid-1950's.

Since many of these browse plants were important primarily as summer and/or fall forage, the extreme grazing and deteriorated condition indicated that summer and fall range conditions were equally as important as winter range to the welfare of mule deer. Winter range conditions directly reflected the degree of utilization of certain key species during summer and fall. Additional utilization of any of the more important summer and fall browse by other animals would have adverse effect on the forage supply and population of mule deer.

The home range behavior and restricted movement of mule deer may also have affected interspecific relations. In contrast to mule deer, elk moved extensively in response to changes in availability of forage during all seasons and thus were capable of substantial impact on forage supplies of individual deer.

It seems apparent that direct competition of elk with mule deer must have occurred during the April–September period, especially early spring, of most years. In comparison with the April–September period, conflict during late fall and winter would be of minor importance and related to occasional feeding by elk on browse plants important to mule deer on local areas.

The evidence indicated that elk were more efficient competitors than mule deer. Elk intensively used most habitat types, topographic sites, as well as all classes of forage during the year or as necessary under the various conditions which prevailed during the 4-year period. Mule deer consistently used a limited number of habitat types and were strongly restricted in their diet of browse and forbs, except for a single grass species when green and when other forage was limited. Cliff (1939:568) concluded that elk had the advantage over mule deer in competition on winter range in the Blue Mountains of Oregon.

Relations between Elk and Cattle

The distributions of intensive elk and cattle use of habitats overlapped throughout the April–November grazing season. The two animals were extremely similar in habits during spring and fall but generally dissimilar through summer. During winter, elk habits were like those of cattle, but the distribution of elk was restricted to the southeastern and other portions of the study area where only occasional cattle use had occurred previously. Both animals ate grass intensively and in about the same proportion during spring. Feeding on western wheatgrass, the most important forage source for both, was also very similar. The *Artemisia–Agropyron* habitat type was

grazed most intensively by elk as well as cattle. Habits diverged after late May when forbs generally became the most important source of elk forage, and the timbered types received significant elk use. Although some forbs were commonly eaten by both cattle and elk, elk typically utilized only minor amounts of grass which continued as the most important cattle forage. Habits of the two species became increasingly similar during September and were almost identical during October and November.

These data indicated opportunity for direct and intensive interaction between elk and cattle during early spring and fall, especially on the *Artemisia–A. smithii* association in early spring. Conflict of a less direct nature could result because of intensive feeding on western wheatgrass, the favored winter food of both animals, by cattle during the grazing season, and by elk in fall on livestock wintering areas. Intensive grazing on plains muhly, Sandberg bluegrass, and junegrass by elk under various conditions somewhat lessened the conflict on cattle pastures. Actual competition was also limited by the low numbers, distribution, and movements of elk. Elk preferred areas which had received little, if any, prior use by cattle during the same year and moved extensively in response to changes in forage availability and distribution of domestic livestock grazing. They readily used the steeper and timbered habitat types in preference to ridgetops and bottomlands which had recently been grazed by livestock.

The opportunity for elk–cattle interaction increased significantly during periods of severely reduced forb growth when elk intensively utilized grass during summer as well as other seasons.

Relations between Mule Deer and Cattle

The overlap between areas of intensive cattle grazing and greater mule deer densities indicated opportunity for interaction, but food and range-use habits differed substantially. Grass comprised the major portion of the cattle diet, whereas browse and forbs were the most important foods of mule deer. More extensive, level or gently rolling ridgetop and coulee bottom areas were the sites used most intensively by cattle, whereas mule deer used timbered habitat types on steeper slopes to a large extent. The greatest overlap was in April and early May on the *Artemisia–Agropyron* type, especially the *Artemisia–A. smithii* association. Sandberg bluegrass and several forbs, the occurrence of which probably was related to heavy grazing by cattle in previous years, were commonly eaten by both animals, but western wheatgrass, the most important cattle forage, was grazed only occasionally by mule deer. Forbs received only moderate use by cattle. There was little overlap in food habits during summer, though some forbs and shrubs important to mule deer were eaten occasionally by cattle on certain sites. The degree of overlap increased after late summer when cattle use of the *Pinus–Juniperus* type increased slightly, possibly because of intensive grass utilization on primary range sites during spring and summer; mule deer use of the *Artemisia–Agropyron* type also increased. Rubber rabbitbrush, an important browse plant for mule deer, was eaten in moderate amounts by cattle; this may have increased its palatability for deer because of the latter's preference for clipped stems.

Although cattle fed on shrubs preferred by mule deer only occasionally or to a minor extent, this additional browsing of heavily utilized and deteriorated plants could be construed as detrimental to mule deer.

The opportunity for association and conflict between mule deer and cattle during winter was limited by restriction of cattle to pastures where very little browsing occurred.

MANAGEMENT CONSIDERATIONS

The *Pinus–Juniperus* habitat type on moderate to steep slopes and the *Artemisia–Agropyron* type on smaller ridgetops and along margins of more extensive ridges were key range areas for mule deer. Small to moderately extensive ridgetops dominated

by *Artemisia–Agropyron* in areas of light cattle use appeared to be key areas for elk. Primary range areas for cattle were extensive, unbroken ridgetops as well as coulee bottoms within about a mile of a dependable water source.

Key forage sources for mule deer were skunkbrush sumac and rubber rabbitbrush. When or where these plants were abundant and moderately utilized during summer and fall, big sagebrush and Rocky Mountain juniper were of secondary importance. Western wheatgrass was a key species for both elk and cattle. The abundance, degree of utilization with respect to accepted proper use criteria, and condition of these plants on the key range sites should serve as bases for evaluating range conditions. Yellow sweetclover was extremely important to mule deer and elk, and its heavy use during years of abundance relieved the pressure on key species, especially browse. Although this exotic plant apparently has become established as a part of the vegetation of the Missouri River Breaks, extreme fluctuations in abundance preclude its consideration as a basic forage source for management.

The rather common recurrence of drought conditions every 3 to 4 years must be recognized as a basic limiting factor in range, big game, and livestock management on the area. Consideration should be given to adjusting utilization standards, population levels, and stocking rates to levels compatible with forage supplies during drought periods if basic forage supplies are to be maintained or replaced. Since population levels and their effects on forage utilization and condition were primary factors in range relationships, these adjustments would have broad significance in reduction of interspecific conflict as well as in sustaining healthy productive herds. Mule deer, in particular, should be more rigidly controlled by adequate hunter harvests and maintained at levels which will permit regeneration or replacement of deteriorated browse plants and sustainment of deer populations.

The potential impact of elk on the biota of the Missouri River Breaks should be recognized and given foremost consideration in the management of existing game populations, in introduction of new animal species to the area, and in relation to introduction of elk into other areas along the Missouri River or similar habitat in eastern Montana where "multiple-use" is the object of management. Greater than existing numbers of elk are not likely to be compatible with management to sustain forage supplies and populations of mule deer within the present elk range. Whether existing numbers are compatible is not clear. The relative importance of elk with respect to mule deer as well as other game species and land uses must be evaluated and established as a basis for management. If mule deer are deemed the most important species, elk should not be permitted to increase beyond existing numbers or should be reduced in number from present population levels.

In multiple-use management programs, numbers and management of livestock should be considered on the basis of forage available on primary range areas rather than on types or the entire area. Winter grazing should be restricted from areas where smaller ridges and timbered coulees are closely interspersed. Consideration could also be given to changing the date of onset of livestock grazing to mid-May when plant growth is more advanced. This would eliminate conflict during early spring and reduce possible competition during subsequent periods. In addition, the development and control of water sources associated with primary cattle ranges could serve as a tool to effect better cattle distribution and lessen opportunities for overlapping range use and conflict with game. Water development should not be considered for terminal portions of larger ridges or on smaller ridges where the area available for cattle dispersal on primary range types is limited.

SUMMARY

A study of the food habits, range use, and interspecific relations of mule deer, elk, and

cattle was conducted during 1960–1964 on a 75,000-acre area in the Missouri River Breaks in north-central Montana to provide criteria for management on ponderosa pine–juniper and related vegetation types.

Physiographic, climatic, and land-use characteristics of the area are described. Analyses of canopy coverage of three stands of each of 12 rangeland communities provided data on vegetational characteristics of 8 habitat types, including *Artemisia–Agropyron*, *Agropyron–Poa*, *Pinus–Juniperus*, *Pseudotsuga–Juniperus*, *Artemisia longifolia*, *Agropyron–Symphoricarpos*, *Sarcobatus–Agropyron*, and *Xanthium strumarium*.

A total of 11,581 observations of mule deer, 3,489 of elk, and 25,107 of cattle along 11 vehicle routes during 521 morning and evening periods provided basic data for analyses of populations and range use. Supplementary data were obtained through aerial surveys, checks on hunter harvest, and relocations of individually marked or otherwise recognizable deer and elk.

Estimates of mule deer populations suggested a mean winter density of about 10 deer per square mile for the 1960–1964 period, with a year-to-year trend of declining numbers during 1960–1962 and recovery during 1963–1964. Comparisons of trends in estimated deer numbers with numbers of mule deer observed per trip along vehicle routes indicated that the roadside counts reflected changes in observability rather than numbers of animals on the area. The elk on the study area did not comprise a discrete population. Minimum counts on the area during winters were 70 in 1960–1961, 80 in 1961–1962, 108 in 1962–1963, and 108 in 1963–1964. The calculated mean net recruitment to the population was 35% suggesting possible greater numbers and more rapid increase. Fourteen stockmen held permits to graze 1,646 cattle plus calves on the study area and adjacent prairie. Actual numbers of cattle on the study area varied considerably within and between years.

Mule deer were distributed over the entire area. Variation in seasonal distribution reflected differences in food and range-use habits in relation to availability of preferred forage. Seventy-six relocations of 10 recognizable mule deer over periods of 1 day to 29 months indicated the mule deer movement was largely restricted to relatively small home ranges. Relocations of two marked females over 29 months indicated movement within approximately 300 acres. Relocations of three males to 16, 20, and 21 months of age suggested that males moved more extensively after their second summer. Elk were generally distributed on the south and west-central portion of the study area during summer and the southeast portion during winter. Local distributions varied in relation to forage conditions. Sixty-eight relocations of 13 recognizable elk within periods of 1 day to 4 years showed average movement of 3.4 miles between relocations, with a maximum of 14.5 miles. The extreme mobility enabled elk to adjust rapidly to environmental changes and constantly utilize the most favorable portions of the range. Greatest cattle densities occurred on the southern half of the area during the April–November grazing season. Use of local areas varied in relation to forage availability, water supplies, and weather conditions. Winter grazing was restricted to pastures on the northern and south-central portions of the area.

Mean numbers of animals observed per group were 3.0 mule deer, 6.9 elk, and 6.7 cattle. Average group sizes varied in relation to frequency of occurrence on the *Artemisia–Agropyron* habitat type and certain range sites.

Approximately 90% of the mule deer, elk, and cattle observed were recorded within 3.5 hr after sunrise or before sunset. Intensive activity was concentrated in the first and last hours of daylight except during late winter and early spring when intensive activity persisted through 2.5 to 3.5 hr after sunrise or before sunset. About 54, 70, and 87%, respectively, of all observed mule deer, elk, and cattle were feeding. Decreased proportions of mule deer observed feeding through the 4 years were indicative of increasing wariness.

More than 47% of the mule deer observed during summer were on the *Pinus–Juniperus* habitat type. *Pseudotsuga–Juniperus* ranked second. Use of those types declined after early fall concomitant with increased use on *Artemisia–Agropyron*. The latter received 67 and 76% of the total use for winter and spring, respectively. Low observability indices for mule deer during summer and fall indicated greater than observed use of timbered habitat types during those periods. The occurrence of mule deer on the various types varied between years in relation to influences of precipitation and mule deer populations on abundance of certain forage plants. During summer, elk use was predominantly on coulee bottom and timbered habitat types with more than 50% of the total feeding elk observed on the *Sarcobatus–Agropyron*, *Agropyron–Symphoricarpos*, and *Xanthium* types, collectively. *Pseudotsuga–Juniperus* was especially important for calving during late May and early June and for bedding throughout the summer. After September, use on these types declined concomitant to increased use on *Artemisia–Agropyron*. The latter received nearly 50% of elk feeding during fall and winter and 81% for spring. It received intensive elk use during all seasons under drought conditions which prevailed from 1960 through the spring of 1962. *Pinus–Juniperus* was moderately important in fall and received more than one-third of the total use for winter when open and semiopen slopes were used intensively. Approximately 60 to 70% of the total cattle observed during all seasons were on the *Artemisia–Agropyron* habitat type. The *Sarcobatus–Agropyron* and *Agropyron–Symphoricarpos* types in coulee bottoms collectively received moderate cattle usage during the grazing season. *Pinus–Juniperus* received moderate use by cattle in summer and fall and minor use during winter. Some yearly differences in seasonal occurrence of all three animals on the different habitat types reflected differences in precipitation and its influences on plant growth and water supplies.

Relative occurrence of animals on slopes of various degrees of steepness closely reflected use of habitat types. Approximately 50, 42, and 18%, respectively, of the total mule deer, elk, and cattle were observed on slopes steeper than 10°. Occurrence of all three species on slopes of varying exposures appeared to reflect relative amounts of area with each exposure more strongly than animal preferences.

Distances at which mule deer, elk, and cattle were observed from water were largely related to the distribution of water sources with respect to areas used by the animals during different seasons and years. The distribution of water sources, even during the most arid years, was not a significant factor in determining either mule deer distributions or the distribution of elk within seasonal ranges. Consistent observations of most cattle within a half mile of water indicated that the distribution of cattle on the area was closely related to the distribution of water.

Data from examination of 263 mule deer feeding sites showed that forbs were the most important forage during summer and constituted 56% of the total combined instances of plant use in summer, 23% during fall, 10% during winter, and 35% during spring. Browse constituted 43% of the total use for summer, and 72, 88, and 52%, respectively, of that for fall, winter, and spring when shrubs were the most important source of food. Grass was fed on to a minor extent amounting to a trace, 5, 2, and 13% of respective seasonal use, during summer, fall, winter, and spring. Yellow sweetclover was the principal summer forb. Skunkbrush sumac, rubber rabbitbrush, and big sagebrush were indicated as the most important browse plants for summer–early fall, late fall–early winter, and late winter–early spring. Sandberg bluegrass, when green, was the only grass to be fed on to a major extent by mule deer during any season. Significant changes in the diet of mule deer occurred during September, late November or early December, late March or early April, and late May.

Feeding on forage classes and individual taxa varied significantly between years in relation to precipitation and its influence on plant growth. Intensive and unseasonally early utilization of browse during 1960 and 1961 was associated with decreased availability of forbs. Intensive feeding on yellow sweetclover in years of abundance buffered use on important browse species.

Examination of 178 elk feeding sites showed that forbs were the most important forage during summer. This forage class constituted 75% of the total combined instances of plant use in summer, 23% in fall, 5% in winter, and 13% in spring. Grass was eaten to a minor extent during summer and comprised 11% of the total but was most important during fall, winter, and spring when it comprised 62, 78, and 82%, respectively, of the total seasonal usage. Browse amounted to 14, 15, 17, and 5% of the summer, fall, winter, and spring diet, respectively. Yellow sweetclover was the most important summer forage. Western wheatgrass was the single most important taxon from October through May. It was grazed intensively throughout the summer of 1961 when forb growth was minimal; browse received increased summer use during 1960 as well as 1961. Significant yearlong changes in the diet of elk occurred during September and late May or early June.

Data for 183 cattle feeding sites showed that grass was the predominant forage throughout the year, constituting 82, 64, 76, and 87% of the total instances of plant usage for spring, summer, fall, and winter, respectively. Forbs comprised 18, 33, 17, and 3%, respectively, of total use during those seasons. Browse was a minor item in the diet of cattle at all times, amounting to a trace, 3, 7, and 10% of the diet for respective seasons. Western wheatgrass was the predominant grass fed on throughout the year.

Comparisons of food and range-use habits and behavior of mule deer and elk indicated conflict between April and September, especially during April and early May. Heavy utilization and deteriorated condition of important browse plants for mule deer aggravated conflict after mid-May. The evidence indicated that elk were more efficient competitors than mule deer. Considerable overlap in habits of elk and cattle afforded opportunity for direct conflict during early spring and fall as well as less direct conflict resulting from use of elk wintering areas in summer by cattle and use of cattle wintering areas by elk in fall. Competition was lessened by low numbers, distribution, and movements of elk. The potential for competition between mule deer and cattle was limited by broad differences in food and range-use habits. The greatest opportunities for conflict occurred on the *Artemisia–Agropyron* habitat type in April and early May and during late summer and fall.

LITERATURE CITED

ALLEN, E. O. 1968. Range use, foods, condition, and productivity of white-tailed deer in Montana. J. Wildl. Mgmt. 32(1):130–141.

BLOOD, D. A. 1966. Range relationships of elk and cattle in Riding Mountain National Park, Manitoba. Can. Wildl. Serv., Wildl. Mgmt. Bull., Ser. 1, No. 191:1–62.

BOOTH, W. E. 1950. Flora of Montana, Part I, Conifers and Monocots. Res. Found. Mont. St. Coll., Bozeman. 232pp.

———, AND J. C. WRIGHT. 1962. Flora of Montana, Part II, Dicotyledons. Mont. St. Coll., Bozeman, Mont. 280pp.

BROWN, D. L. 1947. Aerial census of deer and range inspection on Fort Peck Game Range. Mont. Fish Game Dept., P-R Quart. Rept. 7(4):1–8.

———, AND L. E. BROWN. 1950. Mid-winter deer survey, Fort Peck Game Range. Mont. Fish Game Dept., P-R Quart. Rept. 10(1): 17–21.

CLIFF, E. P. 1939. Relationships between elk and mule deer in the Blue Mountains of Oregon. Trans. N. Am. Wildl. Conf. 4:560–569.

COLE, G. F. 1956. The pronghorn antelope—Its range use and food habits in central Montana with special reference to wheat. Mont. Fish Game Dept., Mont. Agric. Exp. Sta., Tech. Bull. No. 516:1–63.

———. 1958a. Big game livestock competition on Montana's mountain rangelands. Mont. Wildl., April 1958:24–30.

———. 1958b. Range survey guide. Mont. Fish Game Dept. Booklet. 18pp. Multilith.

COWAN, I. McT. 1947. Range competition between mule deer, bighorn sheep, and elk in Jasper Park, Alberta. Trans. N. Am. Wildl. Conf. 12:223–227.

COUPLAND, R. T. 1950. Ecology of mixed prairie in Canada. Ecol. Monogr. 20:271–315.

———. 1961. A reconsideration of grassland classification in the northern Great Plains of North America. J. Ecol. 49:135–167.

DASMANN, R. F., AND R. D. TABER. 1956. Behavior of Columbian black-tailed deer with reference to population ecology. J. Mammal. 37(2):143–164.

DASMANN, W. 1949. Deer-livestock forage studies on the interstate winter deer range in California. J. Range Mgmt. 2(4):206–212.

DAUBENMIRE, R. 1952. Forest vegetation of northern Idaho and adjacent Washington, and its bearing upon concepts of vegetation classification. Ecol. Monogr. 22(4):301–330.

———. 1959. A canopy-coverage method of vegetational analysis. Northwest Sci. 33: 43–64.

DEALY, J. E. 1960. The densiometer for measurement of crown intercept above a line transect. U.S. Dept. Agric., Pacif. N.W. For. Range Expt. Sta., Res. Note 199:1–5.

DENIO, R. M. 1938. Elk and deer food and feeding habits. Trans. N. Am. Wildl. Conf. 3:421–427.

GIESEKER, L. F. 1938. Soils of Fergus County. Mont. Agric. Expt. Sta., Bull. 355. 82pp.

———, C. B. MANIFOLD, A. T. STRAHORN, AND O. F. BARTHOLOMEW. 1953. Soil survey, central Montana. U.S. Dept. Agric., Mont. Agric. Expt. Sta., Series 1940, No. 9:1–133.

HANSON, H. C., AND W. WHITMAN. 1938. Characteristics of major grassland types in western North Dakota. Ecol. Monogr. 8:57–114.

HOLLIBAUGH, G. 1944. Fergus Unit Quarterly Report for the 2nd Quarter. Mont. Fish Game Dept. Rept. 8pp. Typewritten.

JANSON, R. G., AND H. D. PICTON. 1959. Big game surveys and investigations, deer surveys phase. Job Compl. Rept., Fed. Aid Proj. No. W-74-R-4. Mont. Fish Game Dept. 30pp. Multilith.

JOHNSON, D. E. 1952. Population studies of deer —Fort Peck Game Range and vicinity. Job Compl. Rept., Fed. Aid Proj. 1-R. Mont. Fish Game Dept. 8pp. Multilith.

JONAS, R. J. 1964. Ecology and management of Merriam's turkey in the Long Pines, southeastern Montana. Mont. Fish Game Dept., Tech. Bull. No. 3:1–36.

JULANDER, O. 1937. Utilization of browse by wildlife. Trans. N. Am. Wildl. Conf. 2: 276–287.

———. 1955. Deer and cattle range relations in Utah. For. Sci. 1(2):130–139.

———. 1958. Techniques in studying competition between big game and livestock. J. Range Mgmt. 11(1):18–21.

———, AND D. E. JEFFERY. 1964. Deer, elk, and cattle range relations on summer range in Utah. Trans. N. Am. Wildl. Conf. 29: 404–417.

KIMBALL, T. L., AND A. G. WATKINS. 1951. The Kaibab North cooperative deer-livestock forage relationships study. Ariz. Game Fish Comm. Publ. 77pp.

KOCH, E. 1941. Big game in Montana from early historical records. J. Wildl. Mgmt. 5(4):357–370.

LEMON, P. E. 1956. A spherical densiometer for estimating forest over-story density. For. Sci. 2(4):314–320.

LEOPOLD, A., L. K. SOWLS, AND D. L. SPENCER. 1947. A survey of over-populated deer ranges in the United States. J. Wildl. Mgmt. 11(2):162–177.

LOVAAS, A. L. 1963. Gallatin big game studies. Job. Compl. Rept., Fed. Aid Proj. W-98-R-4. Mont. Fish Game Dept. 37pp. Multilith.

MACKIE, R. J. 1966a. Some observations on range use and food habits of domestic sheep in the Missouri River Breaks, Montana. Job Compl. Rept., Fed. Aid Proj. W-98-R-7. Mont. Fish Game Dept. 11pp. Multilith.

———. 1966b. Some phenomena associated with dynamics of mule deer in the Missouri River Breaks of Montana. Proc. West. Assoc. St. Game Fish Comm. 46:129–133.

MARTIN, A. C., R. H. GENSCH, AND C. P. BROWN. 1946. Alternative methods in upland game bird food analysis. J. Wildl. Mgmt. 10(1): 8–12.

MORRIS, M. S., AND J. E. SCHWARTZ. 1957. Mule deer and elk food habits on the National Bison Range. J. Wildl. Mgmt. 21(2):189–193.

ROBINETTE, W. L. 1966. Mule deer home range and dispersal in Utah. J. Wildl. Mgmt. 30(2): 335–349.

SMITH, D. R., P. O. CURRIE, J. V. BASILE, AND N. C. FRISCHKNECHT. 1963. Methods for measuring forage utilization and differentiating use by different classes of animals. Pp. 93–102 *in* Range Research Methods. U.S. Dept. Agric., Misc. Publ. No. 940.

SMITH, J. G., AND O. JULANDER. 1953. Deer and sheep competition in Utah. J. Wildl. Mgmt. 17(2):101–112.

STEVENS, D. R. 1966. Range relationships of elk and livestock, Crow Creek Drainage, Montana. J. Wildl. Mgmt. 30(2):349–363.

TRUEBLOOD, R. 1960. Big game surveys and investigations. Job Compl. Rept., Fed. Aid Proj. W-76-R-5. Mont. Fish Game Dept. 30pp. Multilith.

U.S. WEATHER BUREAU. 1943–1964. Climatological data—Montana. Monthly Summaries. U.S. Govt. Print. Off., Washington, D. C.

WEAVER, J. E., AND F. E. CLEMENTS. 1938. Plant ecology. McGraw-Hill Book Co., New York. 601pp.

WRIGHT, J. C., AND E. A. WRIGHT. 1948. Grassland types of southcentral Montana. Ecology 29(4):449–460.

YOUNG, V. A. 1938. The carrying capacity of big game range. J. Wildl. Mgmt. 2(3):131–134.